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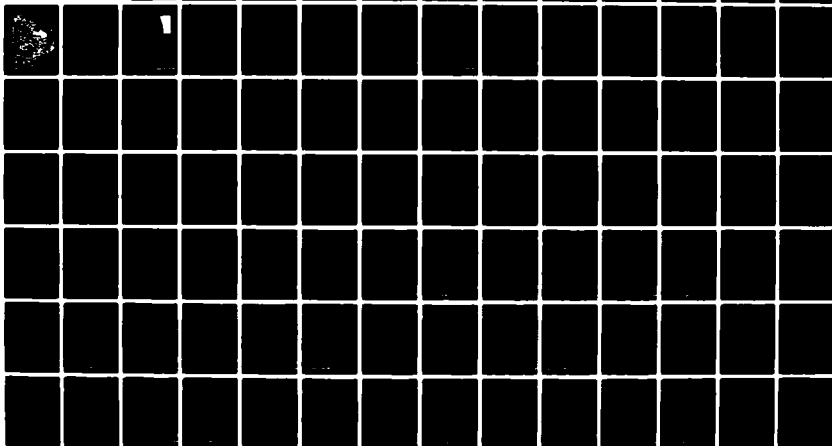
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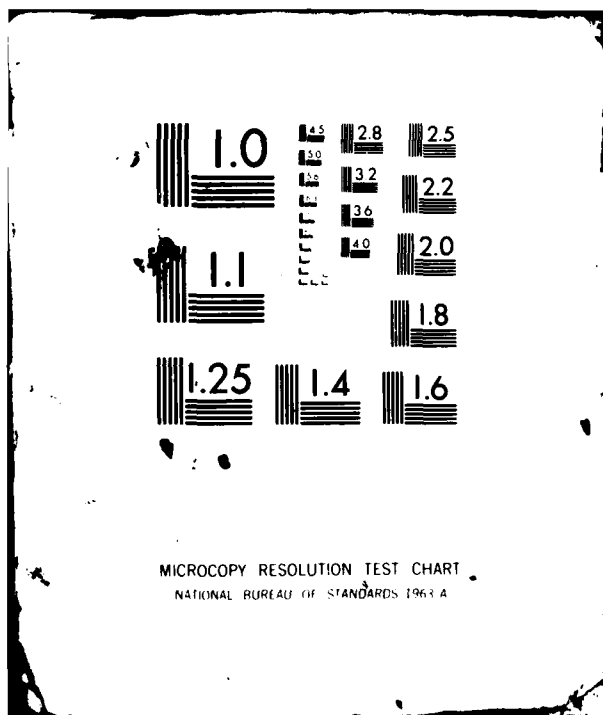
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**MX SITING INVESTIGATION
GEOTECHNICAL EVALUATION**

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**AGGREGATE RESOURCES STUDIES
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MULESHOE VALLEY
DELAMAR VALLEY
PAHROC VALLEY
NEVADA**

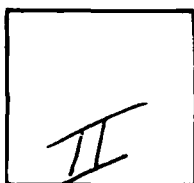
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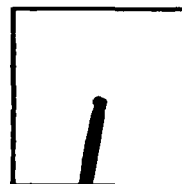
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1. REPORT NUMBER FNTR 372	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Aggregate Resources Studies Dry Lake Valley, Muleshoe, Delamar + Pahre Valley Nevada		5. TYPE OF REPORT & PERIOD COVERED Final
7. AUTHOR(s) Fugro National, Inc		6. PERFORMING ORG. REPORT NUMBER FNTR 372
9. PERFORMING ORGANIZATION NAME AND ADDRESS Ertec Western Inc. (formerly Fugro National) P.O. Box 7765 Long Beach Ca 90807		8. CONTRACT OR GRANT NUMBER(s) F04704-80-C-0006
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Department of the Air Force Space and Missile Systems Organization Norton AFB Ca 92409 (SAMSO)		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 64312 F
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE 6 Jun 80
		13. NUMBER OF PAGES 49
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Distribution Unlimited		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Study of Geologic Setting, Potential aggregate sources, conclusions, recommendations for future studies physiography, Aggregate, Dalicha, soil		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report gives information on the above valleys in location, suitability of basin-fill of rock sources for concrete and road-base construction materials. Three types of aggregate resources are delineated in the four valleys; coarse, fine, and crushed soil aggregate		

AGGREGATE RESOURCES STUDIES

DRY LAKE VALLEY
MULESHOE VALLEY
DELAMAR VALLEY
PAHROC VALLEY

NEVADA

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

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6 June 1980

FUGRO NATIONAL, INC.

FOREWORD

This report was prepared for the Department of the Air Force Ballistic Missile Office (BMO) in compliance with Contract No. F04704-80-C-0006, CDRL Item No. 004A2. It presents the results of Valley-Specific Aggregate Resources studies within and adjacent to selected areas in Utah and Nevada that are under consideration for siting the MX system.

This volume contains the results of the aggregate resources studies in Dry Lake, Muleshoe, Delamar, and Pahroc valleys. It is the first of several Valley-Specific Aggregate Resources investigations which will be prepared as separate volumes. Results of this report are presented as text, appendices, and two drawings.

TABLE OF CONTENTS

	<u>Page</u>
FOREWORD	1
<u>EXECUTIVE SUMMARY</u>	1
1.0 <u>INTRODUCTION</u>	4
1.1 Study Area	4
1.2 Background	4
1.3 Objectives	6
1.4 Scope	6
2.0 <u>STUDY APPROACH</u>	9
2.1 Existing Data	9
2.2 Supplemental Fugro National Data	9
2.3 Data Analysis	11
2.4 Presentation of Results	11
2.5 Preliminary Classification of Potential Aggregate Sources	14
3.0 <u>GEOLOGIC SETTING</u>	17
3.1 Physiography	17
3.2 Location and Description of Geologic Units	17
3.2.1 Rock Units	19
3.2.1.1 Quartzite - Qtz	19
3.2.1.2 Limestone - Ls	20
3.2.1.3 Dolomite - Do	20
3.2.1.4 Carbonate Rocks Undifferentiated - Cau	21
3.2.1.5 Sedimentary Rocks Undifferentiated - Su	21
3.2.1.6 Basalt - Vb	22
3.2.1.7 Volcanic Rocks Undifferentiated - Vu	22
3.2.2 Basin-Fill Units	22
3.2.2.1 Older Lacustrine Deposits - Aol .	23
3.2.2.2 Alluvial Fan Deposits - Aaf	23
3.2.2.3 Stream Channel and Terrace Deposits - Aal	24
3.2.2.4 Alluvial Deposits Undifferentiated - Au	24
4.0 <u>POTENTIAL AGGREGATE SOURCES</u>	26
4.1 Basin-Fill Sources	27
4.1.1 Coarse Aggregate	27

TABLE OF CONTENTS (Cont.)

	<u>Page</u>
4.1.1.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I	27
4.1.1.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II	29
4.1.1.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III	29
4.1.2 Fine Aggregate	29
4.1.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I	29
4.1.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II	30
4.1.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III	32
4.2 Crushed Rock Sources	32
4.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I	32
4.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II	35
4.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III	36
5.0 <u>CONCLUSIONS</u>	37
5.1 Potential Basin-Fill Aggregate Sources	37
5.1.1 Coarse Aggregate	37
5.1.2 Fine Aggregate	38
5.2 Potential Crushed Rock Aggregate Sources	38
6.0 <u>RECOMMENDATIONS FOR FUTURE STUDIES</u>	40
BIBLIOGRAPHY	41

TABLE OF CONTENTS (Cont.)

Page

LIST OF APPENDICES

APPENDIX

A	Fugro National Field Station and Supplementary Test Data and Existing Test Data Summary Tables - Dry Lake, Muleshoe, Delamar, and Pahroc Valleys
B	Summary of Caliche Development
C	Unified Soil Classification System
D	Dry Lake, Muleshoe, Delamar, and Pahroc Valleys Study Area Photographs
E	Fugro National Geologic Unit Cross Reference

LIST OF TABLES

Table
Number

1	Aggregate Tests - Dry Lake, Muleshoe, Delamar, and Pahroc Valleys, Aggregate Resources Study 12
2	Preliminary Aggregate Classification System, Valley-Specific Aggregate Resources Study 15

LIST OF FIGURES

Figure
Number

1	Aggregate Resources Studies Dry Lake, Muleshoe, Delamar, and Pahroc Valleys, Nevada 5
2	Utah-Nevada Regional Aggregate Studies 7

LIST OF DRAWINGS

Drawing
Number

1	Fugro National Field Station and Existing Data Site Locations Dry Lake, Muleshoe, Delamar, and Pahroc Valleys	In Pocket at end of Report
2	Aggregate Resources Map Dry Lake, Muleshoe, Delamar, and Pahroc Valleys	

EXECUTIVE SUMMARY

This report contains the Valley-Specific Aggregate Resources Study (VSARS) evaluation for Dry Lake, Muleshoe, Delamar, and Pahroc valleys in Nevada. It is the first in a series of reports that contain valley-specific aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials. Field reconnaissance and limited laboratory testing, existing data from the State of Nevada Department of Highways, previous regional aggregate investigation, and ongoing Verification studies provide the basis for the findings presented.

A classification system based on aggregate type and potential use was developed to rank the suitability of all basin-fill and rock aggregate sources. Four aggregate types have been designated; coarse, fine, and coarse and fine (multiple) aggregates derived from basin-fill sources and crushed rock aggregates derived from rock sources. Each aggregate type was then classified using the following definitions:

- Class I Potentially suitable concrete aggregate and road-base material source.
- Class II Possibly unsuitable concrete aggregate/potentially suitable road-base material source.
- Class III Unsuitable concrete aggregate or road-base material source.

Decisions on assigning a particular aggregate source to one of the three classes were determined from Fugro National and existing laboratory aggregate tests performed as part of this

study (abrasion resistance, soundness, and alkali reactivity), and to a lesser degree, field visual observations.

Emphasis in this study was placed on the identification of Class I basin-fill, coarse aggregate. These deposits are considered to be the primary sources of concrete and road-base construction materials. Results of the study are presented on a 1:125,000 scale aggregate resources map (Drawing 2) and are summarized as follows:

1. Coarse Aggregate - Three major Class I coarse aggregate basin-fill deposits were located in the four-valley study area.
 - a. An extensive alluvial fan complex west of the Bristol, Highland, and Burnt Springs ranges in east-central Dry Lake Valley.
 - b. Older lacustrine deposits west of Pahroc Valley (Pah-ranagat Valley).
 - c. Limited alluvial fan deposits bordering the Delamar Mountains in east-central Delamar Valley.

Potential Class II coarse aggregate sources are widespread and extensive in the study area. Although boundaries of specific deposits could not be delineated, they are typically located within alluvial fans flanking Class I and/or Class II rock sources.

2. Fine Aggregate - Most coarse aggregate basin-fill sources are also potential multiple sources (coarse and fine) that will supply varying quantities of fine aggregate either from

the natural deposit or during processing. However, specific alluvial fan deposits, predominantly comprised of Class I fine aggregate material were identified in northern Muleshoe Valley flanking the Bristol Range and Dutch John Mountain.

3. Crushed Rock - Abundant Class I crushed rock sources surround the study area. Unnamed upper Cambrian and Pennsylvanian and the Highland Peak and Guilmette formations are widespread carbonate rocks (limestone and dolomite) that compose most Class I sources. Individual units or combinations of these units are most extensive in the northern portions of Muleshoe Valley and eastern Dry Lake and Delamar valleys. The useability of any of these rock units as sources of crushed rock aggregate will depend on their location and accessibility within the study area and minability.

Additional aggregate testing and field investigations will be required to further refine the lateral and vertical extents of classification boundaries and define exact physical and chemical characteristics of a particular deposit or rock source within the valley.

1.0 INTRODUCTION

1.1 STUDY AREA

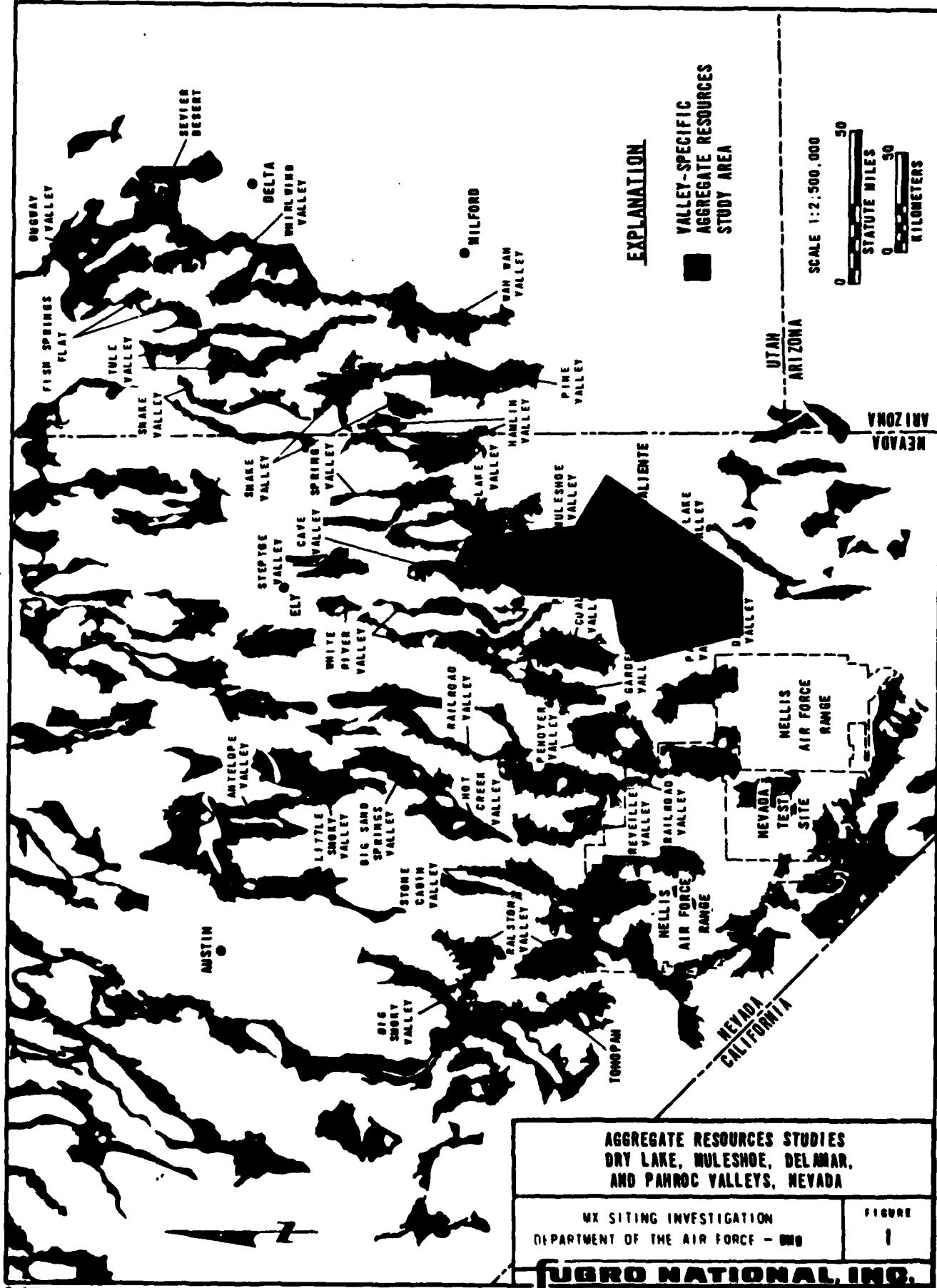
This report presents the results of the Valley-Specific Aggregate Resources Study completed for Dry Lake, Muleshoe, Delamar, and Pahroc valleys (Figure 1). Located in the central portion of Lincoln County, Nevada, the area is elongate in shape with north-south trending alluvial basins flanked by carbonate and volcanic rock mountain ranges. Cave, White River, and Pahrana-gat valleys border the site on the west and Lake and Pine valleys form the eastern boundary.

U.S. Highway 93 provides access along the eastern boundary and to the central study region. State Highway 38, an improved gravel road, provides access to the western border. A network of unpaved roads and 4-wheel-drive trails crisscross the site area (Drawing 1).

The valleys are mainly comprised of desert rangeland. Several active mining operations are located in the Bristol and Highland ranges. The towns of Pioche and Caliente, Nevada, lie just within the east-central border of the Valley-Specific area and are serviced by the mainline of the Union Pacific Railroad from Salt Lake City, Utah, to Las Vegas, Nevada.

1.2 BACKGROUND

The MX aggregate program began in 1977 with the investigation of Department of Defense (DOD) and Bureau of Land Management (BLM) lands in California, Nevada, Arizona, New Mexico, and Texas



(FN-TR-20D). Refinement of the MX siting area added portions of Utah and Nevada that were not studied in the initial Aggregate Resources Evaluation Investigation (AREI). This additional area (Figure 2), defined as the Utah Aggregate Resources Study area (UARSA), was evaluated in Fall 1979 and a second general aggregate resources report (FN-TR-34) was submitted on 3 March 1980. Both general aggregate investigations were designed to provide regional information of the general location, quality, and quantity of aggregates that could be used in the construction of the MX system.

Subsequent to the general studies, Valley-Specific Aggregate Resources Studies (VSARS) were developed in FY 79 to provide more detailed information on potential aggregate sources in specified valley areas.

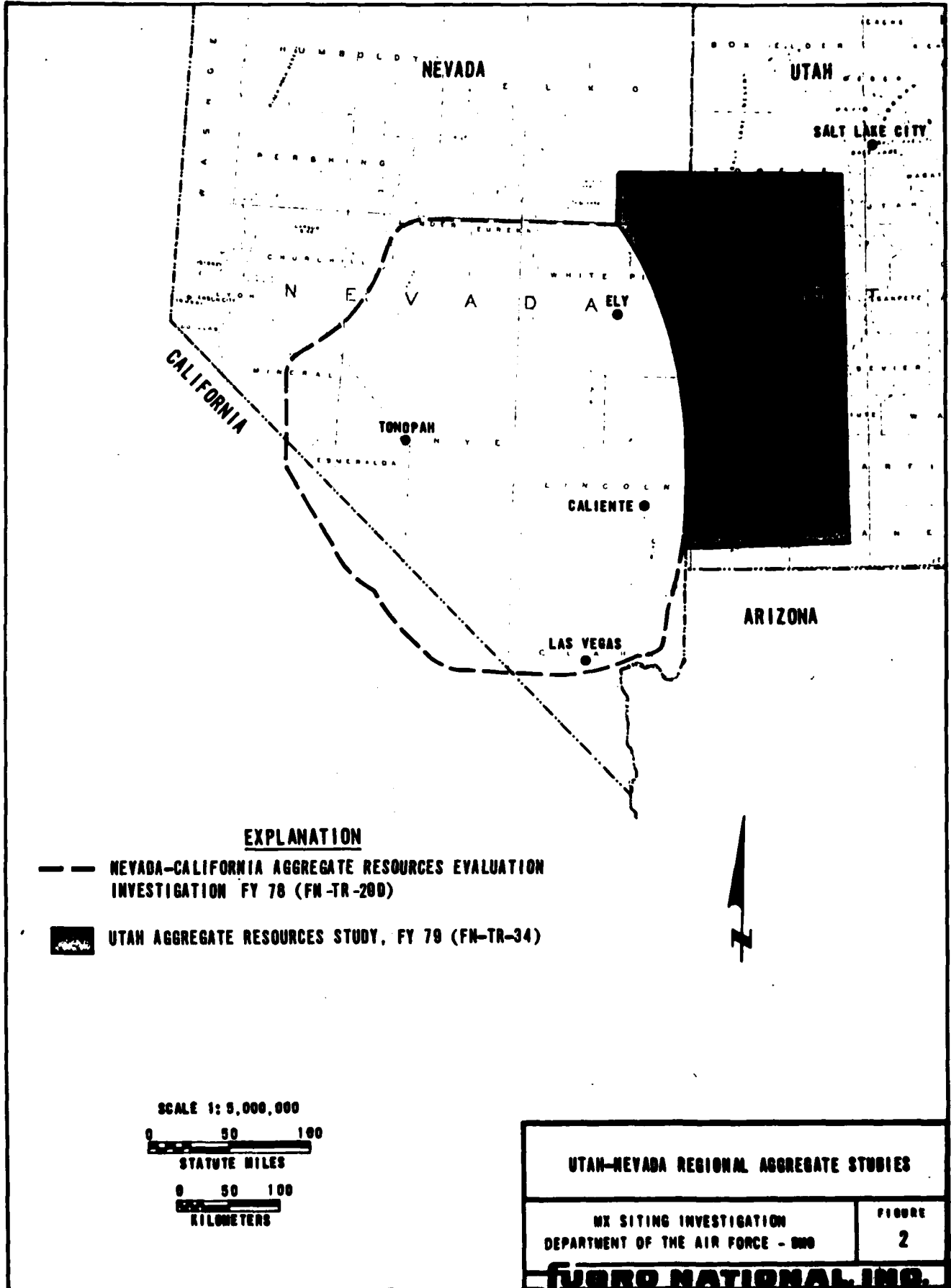
1.3 OBJECTIVES

The primary objective of the VSARS program is to classify on a valley basis, basin-fill deposits and rock for suitability as concrete and road base construction materials. The VSARS format is designed to select and present the locations of the most acceptable aggregate sources for preliminary construction planning and follow-on, detailed aggregate investigations.

1.4 SCOPE

The scope of this investigation required office and field investigations and included the following:

- (1) Collection and analysis of available existing data on the quality and quantity of potential concrete aggregate and road base material sources. American Society



of Testing and Materials (ASTM) standards and Standard Specifications for Public Works Construction (SSPWC) were used to evaluate quality.

- (2) Aerial and ground reconnaissance of all identified potential aggregate sources in the valley area, with more detailed investigation and sample collection of likely basin-fill (coarse and fine aggregates) and rock (crushed rock aggregates) construction material sources.
- (3) Laboratory testing to supplement available existing data and to provide detailed information to assist in determining the suitability of specific basin-fill or rock deposits as construction material sources within the valley area.
- (4) Development and application of an aggregate classification system (Section 2.5) that emphasizes aggregate type (coarse, fine, or crushed rock) and potential construction use (concrete and/or road base).

2.0 STUDY APPROACH

2.1 EXISTING DATA

Collection of existing test data from available sources was an important factor in the VSARS program. The principal source of existing data directly pertaining to aggregate construction materials was the State of Nevada Department of Highways (Appendix A). The majority of this information is related to the use of aggregate material for asphaltic concrete, base course in road construction, or ballast material. However, many of the suitability tests for these types of construction materials are similar to those for concrete and were applicable to this investigation (Appendix A).

2.2 SUPPLEMENTAL FUGRO NATIONAL DATA

Supplemental Fugro National data were obtain from: (1) field data and supplementary test data compiled during the general aggregate resources study (FN-TR-20D), (2) Dry Lake Valley Verification study (FN-TR-27-DL-I and II), (3) Muleshoe, Delamar, and Pahroc Verification studies (in progress), and (4) the current Valley-Specific Aggregate Resources Study (Appendix A).

Although the primary objective of the initial, general aggregate study was directed toward developing regional evaluations and rankings of all potential aggregate sources, the 20 data points included in the Valley-Specific study area (Drawing 1) also supplied specific aggregate information. These 20 stops contained three 100-pound samples collected for limited laboratory testing (Appendix A).

Verification geologic maps were an initial source of information on the type and extent of basin-fill units within specific valley area. In addition, Verification study data included information from 25 trench locations distributed throughout the study area (Drawing 1). Depths of the selected trenches ranged from 5 to 18 feet. While the Verification studies are not specifically designed to generate aggregate data, the sampling techniques and testing procedures (Appendix A) are applicable to the aggregate evaluation.

The VSARS program required aerial and ground reconnaissance of the study area to collect additional information to verify conditions determined during the data review. Included in the 63 field station data stops was the collection of 23 samples for laboratory testing. Potential coarse and fine aggregate basin-fill samples were collected by channel sampling stream cuts or occasional man-made exposures. Potential crushed rock aggregate samples were obtained from exposures of fresh or slightly weathered material whenever possible. The weight of the samples collected range between 100 and 150 pounds. Hand samples, which generally did not exceed 5 pounds in weight, were collected for office analyses.

Identification of basin-fill materials in all field studies followed ASTM D2488-69 Description of Soils (Visual-Manual Procedure), and the Unified Soil Classification System (Appendix C). Rock identifications followed procedures described in the

Quarterly of the Colorado School of Mines and Standard Investigative Nomenclature of Constituents of Natural Mineral Aggregates (ASTM C294-69).

2.3 DATA ANALYSIS

Geologic and engineering criteria were used in the evaluation of potential aggregate sources within the study area. This was supplemented by laboratory analysis of selected samples during the Valley-Specific aggregate testing program (Table 1). Coarse aggregate is defined as plus 0.185 inch (4.699 mm) fine gravel to boulders basin-fill material. Fine aggregate is defined as minus 0.375 inch (9.52 mm) coarse to fine sand basin-fill material. While all laboratory tests supplied definitive information, the soundness, abrasion, and alkali reactivity results were considered the most critical in determining the use and acceptability of a potential aggregate source.

2.4 PRESENTATION OF RESULTS

Results of the study are presented in textual form, tables, two 1:125,000 scale maps, and appendices. Drawing 1 presents the location of the 121 existing test data and supplemental Fugro data sites within the study area. Drawing 2 presents the location of all VSARS laboratory sample sites and all potential basin-fill and rock aggregate sources within the valley area. In addition, these potential aggregate sources are classified according to proposed aggregate use and type (Section 2.5).

ASTM TEST	SAMPLE TYPE AND NUMBER OF TESTS		
	COARSE	FINE	ROCK
ASTM C-88; SOUNDNESS BY USE OF MAGNESIUM SULFATE	11	10	6
ASTM C-131; RESISTANCE TO ABRASION BY USE OF THE LOS ANGELES MACHINE	12		8
ASTM C-136; SIEVE ANALYSIS	12	10	
ASTM C-289; POTENTIAL REACTIVITY OF AGGREGATES (CHEMICAL METHOD)	3	2	3
ASTM C-127 AND C-128; SPECIFIC GRAVITY AND ABSORPTION	9	3	5

**AGGREGATE TESTS
 DRY LAKE, MULESHOE, DELAMAR,
 AND PAHROC VALLEYS
 AGGREGATE RESOURCES STUDIES, NEVADA**

**MX SITING INVESTIGATION
 DEPARTMENT OF THE AIR FORCE - BMO**

**TABLE
 1**

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Geologic unit symbols utilized in Drawing 2 relate to standard geological nomenclature whenever possible. Undifferentiated basin-fill and rock units were established primarily to accommodate accuracy of data and map scale and may contain deposits which could supply significant quantities of high quality materials. A conversion table to relate these geologic symbols to Fugro geologic unit nomenclature is contained in Appendix E.

All contacts which represent distinct boundaries between geologic units are shown as solid lines in Drawing 2. The contacts are dashed where the depicted data were extrapolated beyond the limits of the source data or where accuracy of the data may be questionable. Local small deposits of one geologic unit may be found in close association with a larger deposit of a different geologic unit. Due to the reconnaissance level of the field investigation or scale limitations, these smaller deposits could not be depicted on the aggregate resources map and have been combined with the more prevalent material. Similarly, potential aggregate source classifications are preliminary and may contain lesser amounts of material of another use or type. Therefore, all classification lines are dashed and delimit the best aggregate evaluations possible at this level of investigation. In cases of highly variable rock or basin-fill units and limited aggregate tests, boundaries could not be drawn and information is presented as point data on Drawing 2.

Appendices contain tables summarizing the basic data collected during Fugro National's supplemental field investigations, the

results of Fugro National's supplemental testing programs, and existing test data gathered from various outside sources (Appendix A), an explanation of caliche development (Appendix B), the Unified Soil Classification System (Appendix C), photographs of typical aggregate sources within the study area (Appendix D), and a geologic unit cross reference table (Appendix E).

2.5 PRELIMINARY CLASSIFICATION OF POTENTIAL AGGREGATE SOURCES

A system was developed to preliminarily classify all potential aggregate sources in the study area. This classification is designed to present the best potential sources of coarse, fine, coarse and fine (multiple source), and crushed rock aggregate types within a Valley-Specific area (Drawing 2) based on potential aggregate use (Table 2). Concrete aggregate parameters are the principal consideration in this report as materials suitable for use as concrete aggregate are generally acceptable for use as road-base material. Therefore, the three classifications described below were based primarily on results of the abrasion, soundness, and alkali reactivity tests.

- Class I Potentially suitable concrete aggregate and road base material source. Coarse and crushed rock aggregates which either passed abrasion, soundness, and alkali reactivity tests or passed abrasion and soundness tests and were not tested for alkali reactivity; fine aggregates which either passed soundness and alkali reactivity tests or passed soundness tests and were not tested for alkali reactivity.
- Class II Possibly unsuitable concrete aggregate/potentially suitable road-base material source. Coarse, fine, and crushed rock aggregates which either failed the soundness and/or alkali reactivity tests or were classified only by field visual observations or other test data.

AGGREGATE CHARACTERISTIC ¹			AGGREGATE USE CLASSIFICATION		
			CLASS I	CLASS II	CLASS III
ABRASION RESISTANCE, PERCENT WEAR ²			< 50	< 50	> 50
SOUNDNESS, PERCENT LOSS ³	COARSE AGGREGATE	Na SO ₄	< 12	> 12	> 12
		Mg SO ₄	< 18	> 18	> 18
	FINE AGGREGATE	Na SO ₄	< 10	> 10	> 10
		Mg SO ₄	< 15	> 15	> 15
POTENTIAL ALKALI REACTIVITY ⁴			INNOCUOUS TO POTENTIALLY DELETERIOUS	DELETERIOUS	DELETERIOUS

1. AGGREGATE CHARACTERISTIC BASED ON STANDARD TEST RESULTS
2. ASTM C131 (500 REVOLUTIONS)
3. ASTM C88 (5 CYCLES)
4. ASTM C289

PRELIMINARY AGGREGATE CLASSIFICATION SYSTEM
VALLEY-SPECIFIC AGGREGATE RESOURCES STUDY

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TABLE
2

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Class III Unsuitable concrete aggregate or road base material source. Coarse and crushed rock aggregates which failed abrasion test and were excluded from further testing. Fine, and rarely, coarse aggregates composed of significant amounts of clay- and silt-sized particles.

Sources not specifically identified as Class I, II, or III from the three critical test results or clay- and silt-sized particle content, are designated as Class II sources. All classifications are preliminary with additional field reconnaissance, testing, and case history studies needed to confirm adequacy, delimit areal boundaries, and define exact physical and chemical characteristics.

The following publications/sources were used in defining the three use classifications:

- (1) ASTM C33-74A Standard Specifications for Concrete Aggregate,
- (2) SSPWC Part II Construction Sections 200-1.1, 1.4, 1.5, and 1.7,
- (3) Literature applicable to concrete aggregates,
- (4) Industrial producers of concrete aggregates, and
- (5) Consultants in the field of concrete aggregates.

3.0 GEOLOGIC SETTING

3.1 PHYSIOGRAPHY

The study area lies entirely within the Basin and Range physiographic province. Primary physiographic features are controlled by block faulting which has produced the uplifted mountains and down-dropped alluvial filled basins characteristic of this region. Mountain ranges and valley basins generally trend north-south. Elevations within the valley range from about 6400 feet (1950 m) at the northern end of the study area to approximately 4400 feet (1340 m) near the southern terminus. Nine mountain ranges bound the valley basin areas. These are the Schell Creek, North Pahroc, Hiko, and South Pahroc ranges on the west and the Fairview, Bristol, Ely Springs, Highland, Burnt Springs, Chief, and Delamar ranges on the east (Drawing 2). Topographic relief between mountain ridges and basins is generally greatest along the northern and eastern valley margins and ranges from 1000 to 4000 feet (305 to 1220 m). Drainage is essentially closed within Dry Lake and Delamar valleys, whereas, open drainage characterizes Muleshoe and Pahroc valleys.

3.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Paleozoic, Mesozoic, and Cenozoic rocks are found in bedrock highs and mountains within and adjacent to the study area (Drawing 2). Paleozoic sediments consist predominantly of massively to thinly bedded limestones and dolomites with interbedded sandstones, shales, and quartzites. These sediments are located across the entire Valley-Specific area, and where not

exposed in bedrock highs, underlie younger geologic units. Unconformably overlying Paleozoic rocks within the site region are Mesozoic deposits consisting predominantly of undifferentiated volcanic and intravolcanic sedimentary rocks principally composed of pyroclastics, mud flows, and breccias of andesitic composition.

Cenozoic rocks unconformably overlies Paleozoic and Mesozoic units. These rocks consist of Tertiary intrusives, volcanics, and Quaternary alluvial sediments. Tertiary volcanic rocks are composed predominantly of a pyroclastic series of welded and nonwelded vitric and crystalline tuffs that range from mafic to rhyolitic in composition.

Quaternary alluvial deposits lie unconformably above all older units and consist primarily of Late Pliocene and Pleistocene alluvial fan, lacustrine, stream channel, and terrace deposits. These units may reach a combined thickness of many thousands of feet in the valley centers.

These geologic units have been grouped into eight rock and four basin-fill geologic units for use in discussing potential aggregate sources. The grouping of these units was based on similarities in physical and chemical characteristics and map scale limitations. The resulting units simplify discussion and presentation without altering the conclusions of the study.

3.2.1 Rock Units

Geologic rock units were grouped into the following eight categories (Drawing 2): quartzite (Qtz), limestone (Ls), dolomite (Do), carbonate rocks undifferentiated (Cau), sedimentary rocks undifferentiated (Su), granitic rocks (Gr), basalt (Vb), and volcanic rocks undifferentiated (Vu). Class II granitic rocks that crop out in the southern portion of the Bristol Range are of limited areal extent and will not be discussed.

3.2.1.1 Quartzite - Qtz

Two lower Paleozoic quartzite deposits, the Prospect Mountain and Eureka quartzites, crop out in the Valley-Specific study area. Major deposits of the Prospect Mountain Quartzite are located along the east-central and southeastern margin of the site area along the west flank of the Highland Range, in the southern end of the Chief Range, and within the west-central portion of the Delamar Mountains (Drawing 2). The formation consists of reddish brown to white, thin to massively bedded, well indurated, fine-grained quartzite with interbeds of less resistant quartzite, micaceous shale, pebble conglomerates, and arkosic sandstone layers. Diabase dikes and sills of basaltic appearance locally intrude the formation.

The Eureka quartzite crops out as small units in the central portion of the study area. It is thin, generally less than 500 feet (150 m) thick, and because of its close association with the Pogonip Group (Cau) is often mapped with this

formation. Quartzite units are present at the north end of Burnt Springs and North Pahroc ranges and the south end of the Ely Springs Range. The formation is white or light gray in appearance, vitreous, sugary, fine- to medium-grained, massive orthoquartzite. Interbedded sandstones and dolomitic sandstones occur at the top and bottom of the formation.

3.2.1.2 Limestone - Ls

Limestone is a carbonate rock which is hard, durable, medium-to massively bedded and a major cliff former within the study area. Mapped units represent upper Paleozoic sediments principally of Mississippian, Pennsylvanian, and Permian age. Formations represented include the Pogonip Group, the Joanna, Mercury, and unnamed Pennsylvanian and Permian limestones. The limestones are typically medium to dark gray, fine- to medium-grained, fossiliferous, and sparsely cherty, with well-developed bedding and jointing. This unit is mapped chiefly in the northern portion of the study area, with major deposits occurring in the Grassy and Dutch John mountains, and at the northern end of the North Pahroc Range.

3.2.1.3 Dolomite - Do

Dolomite is a high magnesium carbonate rock that is characteristically dark to medium gray in appearance, medium-grained, sparsely to moderately cherty, hard, with well-developed bedding and jointing. Principal formations that comprise the bulk of this unit are the lower Paleozoic Ely Springs, Laketown, Sevy, and Simonson dolomites. Major deposits are mapped in the Hiko

Range west of Pahroc Valley, within the Schell Range west of Muleshoe Valley, and the Ely Springs Range.

3.2.1.4 Carbonate Rocks Undifferentiated - Cau

Materials classified as undifferentiated carbonate rocks include thick, complex sequences of limestone and dolomite with thin interbeds of sandstone, shale, and siltstone. Individual units are not delineated separately due to map scale limitations and the highly interbedded nature of these units. Principal formations in this unit include the Highland Peak, Guilmette, and unnamed Permian and Pennsylvanian deposits. These rocks are typically light to dark gray in appearance, thinly to massively bedded, hard, cherty, fossiliferous, and are durable cliff formers. Undifferentiated carbonate units are the most extensive of the mapped sedimentary rock units within the study area. The Bristol and Highland Ranges along the east-central margins of the site are almost entirely mapped as undifferentiated carbonate rocks.

3.2.1.5 Sedimentary Rocks Undifferentiated - Su

Geologic formations mapped as undifferentiated sedimentary rocks include interbedded sandstone, shale, dolomite, limestone, and quartzite that may have been slightly metamorphosed in some areas. These deposits are characterized by poorly indurated material and complex, thin to medium bedding. The highly interbedded nature of these units prevents separation into individual rock types (limestones, dolomites). Undifferentiated sedimentary rocks are not a major unit within the site region

and are located primarily in small areas along the west and east margins in the central study area.

3.2.1.6 Basalt - Vb

Tertiary basalt mapped in the study area is characteristically dense, dark gray to black, medium to thick bedded, locally vesicular, and poorly jointed. Occassionally, interbeds of volcanic agglomerate and pumice are present. Basalt is of minor extent and outcrops primarily in and adjacent to the North Pahroc Range.

3.2.1.7 Volcanic Rocks Undifferentiated

Undifferentiated volcanic rocks comprise the most extensive rock unit in the study area. They range from Cretaceous to Pliocene in age and consist predominantly of welded and nonwelded pyroclastics (air falls, ash flows, ignimbrites) of rhyolitic and andesitic composition.

These volcanics also include intravolcanic sedimentary rock consisting primarily of gravel, sand, and silt. Individual rock units have not been delineated because of map scale limitations and complex, but similar composition.

3.2.2 Basin-Fill Units

Four basin-fill units are mapped and labelled within the study area (Drawing 2). These consist of alluvial fan (Aaf), older lacustrine (Aol), stream channel and terrace (Aal), and undifferentiated alluvial deposits (Au). Gravel (g) and sand (s) grain-size designations have been assigned basin-fill units in

the Verification mapped areas (e.g. Aafg). Recent playa deposits, a fifth basin-fill unit, are also present in Dry Lake and Delamar valleys, but these are labelled as unsuitable aggregate sources and will not be discussed.

3.2.2.1 Older Lacustrine Deposits - Aol

Older lacustrine deposits were formed during late Pliocene/early Pleistocene time in response to a much wetter climate. These deposits are located at topographically higher elevations than recent playa deposits in the valley centers and are usually intermixed with or overlain by alluvial fan deposits. They range from coarse gravels to sands, silts, and clays. Classification of these deposits depends primarily on texture and clast composition. They occur principally in portions of Dry Lake Valley and on the flanks of Pahrnagat Valley, west of the Pahroc Valley study area (Drawing 2).

3.2.2.2 Alluvial Fan Deposits - Aaf

Alluvial fans bordering the mountain fronts and extending out into the valley basins are the most extensive basin-fill deposits within the study area. They are typically heterogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay that grade from very coarse-grained near the rock/alluvium contact to fine-grained near the valley centers. Individual fan units contain poorly to well graded, angular to subangular particles and exhibit considerable lateral and vertical textural variation. Composition of the surrounding source rock strongly controls the textural properties of material found

in alluvial fan deposits. Fan units formed at the base of carbonate or quartzitic rocks are characteristically coarse grained, whereas fans developed from volcanic sources tend to be finer grained.

Caliche development in soils, a natural process of soil development in arid climates, ranges from none in younger fans to Stage III (Appendix B) in older units.

3.2.2.3 Stream Channel and Terrace Deposits - Aal

Stream channel and terrace deposits within the study area are associated with primary and secondary ephemeral streams. Secondary ephemeral streams commonly transect alluvial fan deposits and trend normal to the ranges toward the valley axis. There, they terminate in a central playa area (Dry Lake, Delamar Lake) or a primary drainage system (Muleshoe Valley). Most are too small to be depicted on Drawing 2 and have been grouped with adjacent, more prominent units (i.e., alluvial fan, undifferentiated alluvium). These deposits vary from homogeneous to poorly stratified mixtures of sand, gravel, cobbles, and boulders near mountain fronts to sands, silts, and clays near valley centers.

3.2.2.4 Alluvial Deposits Undifferentiated - Au

Undifferentiated alluvial deposits consist of combinations of basin-fill units that were not delineated and mapped during the Verification program. Included in this group are alluvial fans, older lacustrine, stream channel, stream terrace, and pediment deposits. These alluvial deposits are homogeneous to stratified

mixtures of boulders, cobbles, gravel, sand, silt, and clay derived from a wide range of rock types. Composition varies according to the characteristics of the individual units and the source rock type. Undifferentiated alluvial deposits are generally located along the inside margins of the valley-specific boundaries around the study region (Drawing 2).

4.0 POTENTIAL AGGREGATE SOURCES

Based on the results of field visual observations and aggregate testing, potential basin-fill and rock sources were divided into three basic material types (i.e., coarse, fine, and crushed rock) and classified into one of the three use categories (Section 2.5). Basin-fill deposits tested in the study area may be placed within a multiple type category, (coarse and fine aggregate source). Coarse aggregate is defined as plus 0.185 inch (4.699 mm) fine gravel to boulders and fine aggregate is defined as minus 0.375 inch (9.52 mm) coarse to fine sand.

Classification boundaries (Drawing 2) of basin-fill aggregate sources were generalized and will require additional studies to accurately define their location. Boundaries of identified crushed rock sources are based on the areal map extent of the geologic formations tested (i.e., Eureka Quartzite, Guilmette Formation, Pogonip Group) and not on the aggregate geologic unit (i.e., Cau, Do, Qtz) described in Section 3.2.1.

In the following discussion, the best potential coarse, fine, or crushed rock source within each Class I and Class II category is presented first; followed by successively less probable sources. This ranking of deposits is preliminary and based upon an analysis of Fugro National and exisiting data.

4.1 BASIN-FILL SOURCES

4.1.1 Coarse Aggregate

4.1.1.1 Potentially Suitable Concrete Aggregate and Road Base Material Sources - Class I

Extensive Class I coarse aggregate sources are located along the east side of Dry Lake Valley in alluvial fan units bordering the Class I crushed rock sources in Bristol, Highland Peak, West, Ely Springs, and Burnt Springs ranges (Drawing 2). The alluvial fan units consist predominantly of moderately to moderately well graded, sandy gravels with subangular to subrounded carbonate and quartzite clasts. Laboratory test data indicate these deposits have acceptable abrasion, soundness, and alkali reactivity values for Class I coarse material (Appendix A). Sieve analysis of these samples suggest that the fan deposits are biased toward the fine end and may lack material in the coarse fraction for crushing. Overburden averages 1 to 3 meters and consists predominantly of caliche cemented gravels (Stage II to III).

Access to these deposits is provided by several unpaved roads that crisscross the area and minability is considered good to excellent. Additional field reconnaissance and testing will be necessary to accurately define the limits of this source.

Class I coarse aggregate deposits are also present in older lacustrine deposits (Aolg) within Pahrnagat Valley southwest of Pahroc Valley (Drawing 2). These deposits consist of moderately well-graded, medium dense to dense, stratified sandy gravels composed primarily of carbonate clasts. Coarse fragments are

subrounded and sufficient material greater than 3/4-inch exists for crushing. Testing was completed on two samples at widely separated locations and test results are available from three State of Nevada Highway pits. Results were positive, with acceptable losses in the abrasion and soundness tests. Overburden ranged from 1 to 5 meters (averaging 2.5 meters) and consists primarily of sandy material.

Limited coarse alluvial fan deposits (Aafg) in east-central Delamar Valley were also identified as Class I aggregate sources (Drawing 2). The unit consists of moderately well-graded, medium dense, sandy gravels derived primarily from nearby quartzite and carbonate rocks. Seive analysis indicates sufficient quantities of material exist above the 3/4-inch size for crushing. Abrasion and soundness losses were within acceptable limits but testing for alkali reactivity was not made on this sample. Overburden thickness averages less than 1 meter on this deposit.

Additional Class I coarse aggregate sources are present in alluvial fan deposits east of Dutch John Mountain at the north end of the study area. These deposits consist of medium dense, poorly graded sandy gravels with overburden averaging less than 1 meter in thickness. Although boundaries of this unit could not be drawn from the field reconnaissance and limited laboratory testing, field observations suggest that most alluvial fan units bordering Class I rock sources at the northern end of the study area may qualify as Class I aggregate sources.

4.1.1.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

A limited stream channel deposit in Antelope Canyon, just north of Caliente, Nevada, was identified during the investigation as a Class II source of coarse aggregate. This deposit is composed primarily of quartzitic clasts derived from the Prospect Mountain Quartzite (Class II rock source). The deposit consists of medium dense, moderately well-graded, sandy gravel with subangular to subrounded clasts. Test results indicate an acceptable abrasion loss but lack of soundness results require a Class II ranking. A favorable soundness test would qualify this unit as Class I.

Based on field observations, Class II coarse material may be present in alluvial fans near the rock/ alluvium contact of nearly all mountain ranges. Access and mining of these sources should be good to excellent across the study region.

4.1.1.3 Unsuitable Concrete Aggregate or Road Base Material Sources - Class III

No unsuitable coarse aggregate sources were identified in the study area during the Valley-Specific investigation.

4.1.2 Fine Aggregate

4.1.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources-Class I

Class I fine aggregate sources are located in alluvial fan deposits bordering the north end of the Bristol Mountain Range and consist of medium dense, moderately well-graded, gravelly sands (Drawing 2). Gravel clasts within the unit are derived

predominantly from Class I carbonate rocks. Soundness test results are within Class I standards for fine aggregate (Table 2). Field observations indicate that deleterious substances are minor and the overburden thickness averages between 1 and 2 meters. The untested coarse aggregate content ranges from 20 to 40 percent and based on results of aggregate tests for coarse units in the same general fan complex, may also qualify as a Class I source. Access is provided by several unpaved roads that traverse the alluvial fan complex. Minability is considered good to excellent. Boundaries of Class I fine aggregate sources could not be delineated at this level of investigation and will require additional field studies and testing to define accurately.

Class I fine aggregates sources were also identified in alluvial fan deposits east of Dutch John Mountain in the northern portion of the study area. These deposits are predominantly poorly graded sandy gravels that meet Class I requirements for coarse (Section 4.1.1.1) and fine aggregate sources (multiple source). Boundaries of this unit could not be defined at this level of investigation. Based on field observations, other potential Class I fine aggregate sources may exist in alluvial fan or older lacustrine deposits derived from detritus of identified Class I crushed rock sources.

4.1.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Materials Sources - Class II

Class II fine aggregate sources are located in alluvial fan units that receive sediments from the Bristol, Highland, and

Burnt Springs ranges (Drawing 2). These deposits consist of moderately well graded, medium dense, gravelly sands and sandy gravels predominantly of carbonate rock origin. Gravel comprises from 13 to 55 percent of the sieved samples with clasts consisting primarily of limestones and dolomites derived from the nearby mountain ranges. Soundness losses were unacceptable and alkali reactivity tests were not run on these samples.

Abrasion and soundness tests completed for the coarse material from the same alluvial fan complex are well within Class I standards (Table 2). Based on these results, aggregate sources in these areas may provide good multiple sources where gravels comprise a significant percentage of the deposit (Section 4.1.1.1).

An additional Class II fine aggregate source of limited areal extent was noted in a stream channel deposit in Antelope Canyon, just north of Caliente, Nevada. Sand-sized particles comprise up to 45 percent of this sandy gravel multiple source unit whose coarse fraction tested as a Class II coarse aggregate source.

Boundaries of Class II fine aggregate sources could not be delineated on Drawing 2 at this level of investigation and will require additional field reconnaissance and testing to accurately delineate. Additional sources of Class II fine aggregate are probably available in almost all alluvial fan units bordering Class I crushed rock sources.

4.1.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

Class III fine aggregate sources are located in the valley basins and are comprised predominantly of older lacustrine and recent playa deposits (Drawing 2). These sediments are typically interbedded and stratified moderately dense fine sand, silt, and clay.

4.2 CRUSHED ROCK SOURCES

4.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I

Class I crushed rock sources are widely distributed throughout the study area. The most extensive deposits occur in the Bristol, Highland, and Burnt Springs ranges in east-central Dry Lake Valley (Drawing 2) and consist primarily of limestones and dolomites from the Highland Peak formation and unnamed Upper Cambrian limestones and dolomites (Cau). Field observations and limited laboratory testing (Appendix A) of the Highland Peak Formation indicate that splitting characteristics are favorable for crushing and abrasion and soundness losses are moderate to low (Table 2). Alkali reactivity tests have not been completed on this formation. Limestone from this rock unit has been previously quarried at the south end of the Highland Range and used in road construction. This formation also forms the principal Class I material of the Burnt Springs Range and is the major crushed rock source in the central Delamar Mountains.

Unnamed Upper Cambrian limestones and dolomites, although not as extensive as the Highland Peak Formation, are also present as

major deposits in the Highland, Burnt Springs, and Ely Spring ranges. Limited field observations suggest that the limestones within this formation are hard, have good splitting characteristics and no observable deleterious properties. Test results show no undesirable aggregate characteristics for a Class I rock unit (Table 2), however, alkali reactivity has not been tested in this source.

Access to deposits in the Bristol and Highland ranges is provided by numerous unpaved roads from Pioche, Nevada to the east and the valley basin to the west. The minability of these deposits is considered fair to very good, depending primarily on the slope of the terrain and the repose of the rock unit. Class I deposits of the Burnt Springs and Ely Springs ranges, because of their close proximity to the valley basin, would provide an excellent, highly accessibly and minable source of Class I crushed rock aggregate for the southcentral portion of the area of investigation.

Unnamed Pennsylvanian limestones (Ls) and the Guilmette Formation (Cau) form large Class I crushed rock sources at the northern end of the study area (Drawing 2). Major deposits of Pennsylvanian limestone occur primarily within the Dutch John and Grassy mountains region, northern North Pahroc Range, and as small units in the Schell Creek Range. Abrasion, soundness, and alkali reactivity test results are all well within Class I requirements. Field observations indicate that the formation is hard to very hard, fine grained, and has slabby splitting

characteristics. Existing unpaved roads provide good access to exposures of this formation located near the rock/alluvium contact and the minability of this unit is generally considered good.

The Guilmette Formation forms numerous bedrock highs and low hills in the northern half of the Dry Lake study area. Scattered small knolls composed of rocks primarily from this formation lie within the valley basin parallel to and east of the North Pahroc Range. The Guilmette Formation forms about one-half of the West Range in the east-central portion of the region and portions of the Schell Creek Range and Dutch John Mountain at the northern end of the study area. A small section of this unit is also located in the Hiko Range bordering Pahroc Valley in the southwest portion of the area of investigation. Data from laboratory testing indicates that the limestones display acceptable abrasion and soundness values. Alkali reactivity tests were not run on this unit. Field observations indicate rock jointing is favorable and deleterious materials were generally minor in extent. Access and minability is excellent, especially for those units located within the valley basin.

Class I andesitic volcanic rocks (Vu) were identified at the northern end of the Bristol Range (Drawing 2). While not considered a primary source of Class I crushed rock due to lateral and vertical lithologic variations, acceptable test results indicate that volcanic rocks of this composition could

make potentially suitable crushed rock sources in areas where unit boundaries can be defined.

A sandstone member within the Simonson Dolomite (Do) was the only Class I crushed rock aggregate source tested in Pahroc Valley. Although the formation forms major deposits within the Hiko Range in the southwest section of the region and small deposits within the Schell Creek Range at the northern end of the study area, Class I ranking was given only to the sandstone unit. Additional laboratory testing will be necessary to classify the acceptability of the entire formation as a Class I aggregate source. The access and minability of this crushed rock source is considered very good within the Hiko Range.

4.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

No Class II crushed rock aggregate sources were specifically identified from the laboratory testing program. Extensive rock units indicated on Drawing 2 as Class II crushed rock sources were classified only by field visual observations. The predominant types of rock in this category are undifferentiated volcanics of a highly variable lithologic composition and certain Paleozoic carbonates and sedimentary rocks.

The Prospect Mountain Quartzite (Qtz) was identified as a Class II crushed rock source within the Chief Range at the southern end of Dry Lake Valley and in Delamar Valley within the central portion of the Delamar Range. Field observations indicate that

the quartzite is very hard, having slabby splitting characteristics, and no deleterious materials. A Class II ranking was given this formation because direct measurements of aggregate characteristics were not made. However, further examination and laboratory testing may give it a Class I designation.

4.2.3 Unsuitable Concrete Aggregate or Road Base Material Sources - Class III

Two crushed rock aggregate sources failed aggregate abrasion tests and were identified as Class III geologic units. The unsuitable sources included an exposure of Eureka Quartzite (Qtz) at the northern end of the Burnt Springs Range and rhyolitic tuffs (Vu) located at the southern end of Delamar Valley (Drawing 2).

5.0 CONCLUSIONS

Results of the Valley-Specific aggregate investigation indicate that potentially good to high quality (Classes I and II) basin-fill and crushed rock aggregate sources are present within the Dry Lake, Muleshoe, Delamar, and Pahroc Valley Specific study area to meet construction requirements of the MX system (Drawing 2).

5.1 POTENTIAL BASIN-FILL AGGREGATE SOURCES

5.1.1 Coarse Aggregate

Major Class I coarse aggregate deposits listed in order of potential suitability, have been identified within the following areas:

1. Alluvial fan deposits west of the Bristol, Highland, and Burnt Springs ranges in east-central Dry Lake Valley,
2. Older lacustrine sediments west of Pahroc Valley (Pahranagat Valley), and
3. Alluvial fans bordering the Delamar Mountains in east-central Delamar Valley.

Field observations indicate additional sources of Class I coarse aggregate may be available in alluvial fan deposits adjacent to the rock/ alluvium contact of Class I crushed rock sources.

Potential Class II coarse aggregate sources are widespread and extensive in the study area. Although boundaries of specific deposits could not be delineated, they are typically located within alluvial fans flanking Class I and/or Class II rock sources.

5.1.2 Fine Aggregate

While most coarse aggregate sources will supply quantities of fine aggregate either from the natural deposits or during processing, several fine aggregate sources were sampled and tested. Class I fine aggregate deposits were identified in alluvial fans bordering Class I rock sources at the north end of the Bristol Range and near Dutch John Mountain (multiple sources). Further field reconnaissance will be required to identify and delineate additional Class I fine aggregate sources, however, based on field observations, potential sources may exist in alluvial fan units derived from Class I rock sources.

Potential Class II fine aggregate sources are widespread and extensive in the study area. Specific deposit boundaries could not be delineated but typically occur basinward of most Class I and Class II coarse aggregate deposits and/or rock exposures.

5.2 POTENTIAL CRUSHED ROCK AGGREGATE SOURCES

Class I crushed rock sources exist in most sections of the study area. The most suitable deposits and their corresponding locations are listed below:

1. Unnamed Upper Cambrian - Eastern Dry Lake Valley
and Pennsylvanian car- (Bristol, Highland, Ely
bonates Highland Peak Springs, West, and Chief
Formation Guilmette ranges)
Formation
2. Highland Peak Formation - Eastern Delamar Valley
(Central Delamar Mountains)

3. Unnamed Pennsylvanian limestones - Northern Muleshoe Valley (Schell Creek Range and Dutch John and Grassy mountains)
4. Guilmette Formation - Northwestern Pahroc Valley (Hiko Range)

Class I crushed rock sources, exposed within the Burnt Springs, West and Ely Springs ranges, because of their close proximity to the valley basin and good to excellent minability, could provide crushed rock material for much of the central valley area. Undifferentiated volcanics and limited sedimentary units widely distributed throughout the study area comprise most of the Class II crushed rock sources delineated on Drawing 2.

6.0 RECOMMENDATIONS FOR FUTURE STUDIES

Future aggregate studies should include a program to refine the lateral and vertical boundaries of Class I basin-fill, coarse aggregate sources and define their exact physical and chemical characteristics. The following procedures are recommended to achieve these objectives.

1. An examination of stereo aerial photographs of the Class I basin-fill and surrounding areas. Emphasis should be placed on the determination of grain-size and compositional variations within the preliminarily defined Class I source areas and the delineation of any subareas.
2. Field reconnaissance and selection of areas for sampling with standard backhoe equipment.
3. A laboratory aggregate testing program to evaluate the concrete making properties of the Class I basin-fill aggregate sources. This should include a concrete mix design test program and where needed, additional Los Angeles abrasion, soundness, and alkali reactivity tests.

This study would provide information on the relative economic aspects of the various Class I basin-fill sources necessary for developing plant designs and locations, mining methods, and concrete mix designs. It should be initiated immediately to minimize any impact on pre-construction planning considerations.

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APPENDIX A

Fugro National Field Station and Supplementary
Test Data and Existing Test Data Summary Tables -
Dry Lake, Muleshoe, Delamar, and Pahroc Valleys

EXPLANATION OF FUGRO NATIONAL
FIELD STATION AND SUPPLEMENTARY
TEST DATA

Fugro National field stations were established at locations throughout the Valley-Specific study area where detailed descriptions of potential basin-fill or rock aggregate sources were recorded (Drawing 1). All field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Data entries record conditions at specific field station locations that have been generalized in the text and Drawing 2. Detailed explanations for the column headings in Table A-1 are as follows:

Column Heading

Explanation

Map Number

This sequentially arranged numbering system was established to facilitate the labelling of Fugro National field station locations and existing data sites on Drawing 1 and to list the correlating information on Tables A-1 and A-2 in an orderly arrangement.

Field Station

Fugro National field station data are comprised of information collected during:

- o The Valley-Specific Aggregate Resources Study; sequentially numbered field stations were completed by two investigative teams (A and B). The Dry Lake Candidate Deployment Area (DLCDP) designation is obsolete. The presently understood study area consists of Dry Lake, Muleshoe, Delamar, and Pahroc valleys.
- o The general aggregate investigation in Nevada (NV); R and H indicate ground and aerial reconnaissance stops, respectively.
- o The Verification study in Dry Lake (DL), Muleshoe (MS), Delamar (DM), and Pahroc

<u>Column Heading</u>	<u>Explanation</u>
Field Station (cont.)	(P) valleys; trench data (T) were restricted to information below the soil horizon (1 to 2 meters).
Location	Lists major physiographic or cultural feature in/or near which field stations or existing data sites are situated.
Geologic Unit	Generalized basin-fill or rock geologic units at field station or existing data locations. Thirteen classifications, emphasizing age and lithologic distinctions were developed from existing geologic maps to accomodate map scale of Drawing 2.
Material Description	Except in cases where soil or rock samples were classified on laboratory results, the descriptions are based on field visual observations utilizing the Unified Soil Classification System (See Appendix C for detailed USCS information).
Field Observations	
Boulders and/or Cobbles, Percent	The estimated percentage of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an average diameter between 3 and 12 inches (8 and 30 cm); boulders have an average diameter of 12 inches (30 cm) or more.
Gravel	Particles that will pass a 3-inch (76 mm) and are retained on No. 4 (4.75 mm) sieve.
Sand	Particles passing No. 4 sieve and retained on No. 200 (0.075 mm) sieve.
Fines	Silt or clay, soil particles passing No. 200.
Plasticity (Index)	Plasticity index is the range of water content, expressed as percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Field classification followed standard descriptions and their ranges are as follows: None - Nonplastic (NP) (PI, 0 - 4) Low - Slightly plastic (PI, 4 - 15) Medium - Medium plastic (PI, 15 - 30) High - Highly plastic (PI, > 31)

Column HeadingExplanation

Hardness	A field test to identify materials that are soft or poorly bonded by estimating their resistance to impact with a rock hammer; classified as either soft, moderately hard, hard, or very hard.
Weathering	Changes in color, texture, strength, chemical composition or other properties of rock outcrops or rock particles due to the action of weather; field classified as either fresh or slight(ly) moderate(ly) or very weathered.
Deleterious Materials	Substances potentially detrimental to concrete performance that may be present in aggregate; includes organic impurities, low density material, (ash, vesicules, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche coatings, clay coatings, mica, gypsum, pyrite, chlorite, and friable materials, also, aggregate that may react chemically or be affected chemically by other external influences.

Laboratory Test Data

Sieve Analysis (ASTM C 136)	The determination of the proportions of particles lying within certain size ranges in granular material by separation on sieves of different size openings; 3-inch, 1 1/2-inch, 3/4-inch, 3/8-inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100 and No. 200.
No. 8, No. 50	Asterisked entries used No. 10 and No. 40 sieves, respectively.
Abrasion Test (ASTM C 131)	A method for testing abrasion resistance of an aggregate by placing a specified amount in a steel drum (the Los Angeles testing machine), rotating it 500 times, and determining the material worn away.
Soundness Test (ASTM C 88) CA, FA	CA = Coarse Aggregate FA = Fine Aggregate The testing of aggregates to determine their resistance to disintegration by saturated solutions of magnesium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate

Column HeadingExplanation

	information is not available from service records of the material exposed to actual weathering conditions.
Specific Gravity and Absorption (ASTM C 127 and 128)	Methods to determine the Bulk Specific Gravity, Bulk SSD Specific Gravity (Saturated - Surface Dry Basis), and Apparent Specific Gravity and Absorption as defined in ASTM E12-70 and ASTM C 125, respectively.
Alkali Reactivity (ASTM C 289)	This method covers chemical determination of the potential reactivity of an aggregate with alkalies in portland cement concrete as indicated by the amount of reaction during 24 h at 80 C between 1 N sodium hydroxide solution and aggregate that has been crushed and sieved to pass a No. 50 (300- μ m) sieve and be retained on a No. 100 (150- μ m) sieve.
Aggregate Use	<p>I = Class I; potentially suitable concrete aggregate and road-base material source.</p> <p>II = Class II; possibly unsuitable concrete aggregate/potentially suitable road-base material source.</p> <p>III = Class III; unsuitable concrete aggregate or road base material source.</p> <p>c = coarse aggregate</p> <p>f = fine aggregate</p> <p>f/c = fine and coarse aggregate</p> <p>cr = crushed rock</p> <p>All sources not specifically identified as Class I, II, or III from the abrasion, soundness, or alkali reactivity tests or the content of clay- and silt-sized particles, are designated as Class II sources.</p>

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	DIST. IN TH
1	DLCDP-A1	Dry Lake Valley	Qtz	Quartzite	SP	T	35
2	DLCDP-A2	Dry Lake Valley	Ls	Limestone			
3	DLCDP-A3	Dry Lake Valley	Aals	Gravelly Sand			
4	DLCDP-A4	Dry Lake Valley	Su	Sandstone			
5	DLCDP-A5	Dry Lake Valley	Do	Dolomite	GP	T	2
6	DLCDP-A6	Schell Creek Mountains	Do	Dolomite			
7	DLCDP-A7	Silver King Mountains	Aafs	Sandy Gravel			
8	DLCDP-A8	Dry Lake Valley	Vu	Welded Tuff			
9	DLCDP-A9	Burnt Peak Mountains	Su	Sandstone	SP	T	
10	DLCDP-A10	Dry Lake Valley	Qtz	Quartzite			
11	DLCDP-A11	Dry Lake Valley	Do	Dolomite			
12	DLCDP-A12	Dry Lake Valley	Aals	Gravelly Sand			
13	DLCDP-A13	Dry Lake Valley	Vu	Tuff			

FIELD OBSERVATIONS																			
SAND/ON COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (A)											
	GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30				
T	35	60	5	None	Hard	Slight	None												
					Hard	Slight	<5% Chert												
							5% Caliche Nodules												
					Very Hard	Slight	Friable												
					Hard	Slight	<5% Chert, Calcite Veins												
					Hard	Slight	Calcite Veins												
T	50	45	5	None			<5% Caliche Nodules												
					Hard	Moderate	Pumice												
					Very Hard	Fresh	None												
					Hard	Slight	None												
					Hard	Slight	Calcite Veins												
T	15	80	5	None			15% Volcanic Ash												
					Soft	Slight	Ash												

LABORATORY TEST DATA

PASSING (ASTM C 136)					ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALN REACT (ASTM C 195)
								COARSE AGGREGATE				FINE AGGREGATE				
								SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT		CA
					22.3	CA	FA	2.80	2.82	2.85	0.57				Innocuous	

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TYPE	PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
		CA	FA	
		Innocuous		IIcr
				IIcr
				IIIf/c
				IIcr
				Icr
				IIcr
				IIc/f
				IIcr
				IIcr
				IIcr
				IIcr
				IIIf
				IIcr

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - DND

TABLE
A-1
PAGE 1 OF 9

FUGRO NATIONAL INC.

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	DIS- SEM- PERCENT
14	DLCDP-A14	Dry Lake Valley	Aafs	Gravelly Sand	SP-SM		
15	DLCDP-A15	Dry Lake Valley	Aafs	Gravelly Sand	SP-SM GP-GM		
16	DLCDP-A16	Dry Lake Valley	Vu	Andesite			
17	DLCDP-A17	Dry Lake Valley	Aafg	Silty Sandy Gravel	GM		
18	DLCDP-A18	Dry Lake Valley	Aafs	Gravelly Sand	SM		
19	DLCDP-A19	Dry Lake Valley	Aals	Gravelly Sand	SP-SM		
20	DLCDP-A20	Dry Lake Valley	Aafs	Silty Sand	SM	0	10
21	DLCDP-A21	Burnt Spring Range	Aafs	Sandy Gravel	GP-GM		
22	DLCDP-A22	Dry Lake Valley	Vu	Ash Flow			
23	DLCDP-A23	Burnt Spring Range	Ls	Limestone			
24	DLCDP-A24	Burnt Spring Range	Ls	Limestone			
25	DLCDP-A25	Dry Lake Valley	Aals	Sandy Gravel	GP		

FIELD OBSERVATIONS

DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (ASTM)							
GRAVEL	SAND	FINES					3"	1½"	¾"	¾"	NO. 4	NO. 8	NO. 16	NO. 30
10	70	20	None	Hard	Slight	10% Caliche Nodules and Friable Mtls.				100	78.8	62.7	46.7	36.2
			None			12% Caliche Nodules	98	94.7	87.4	72.1	55.3	44.2	33.8	25.2
			None			Volcanic Glass and Vesicles								
			None			20% Caliche and Clay Nodules	100	98.3	91.8	76.2	54.5	43.1	36.1	31.1
			None			15% Caliche Nodules				100	81.1	70.2	60.4	51.9
			None			5% Caliche Nodules 5% Pumice				100	86.9	64.8	43.4	28.5
			None	Mod. Hard Hard Hard	Moderate Slight Slight	None								
			None			Volcanic Glass, Caliche Coatings	93.7	84.3	73.3	59.7	46.5	38.4	30.2	22.9
						Volcanic Glass and Pumice								
						None								
						Calcite Veins								
						10% Intermediate Volcanics	100	99	90.2	67.6	66.5			

LABORATORY TEST DATA

G (ASTM C 136)				ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 203)			
							COARSE AGGREGATE				FINE AGGREGATE							
							SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION				
NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT					
						CA	FA											
	36.2	27.1	15.9	9.7			12.6						2.63	2.68	2.77	1.96		
	25.2	17.0	11.4	7.5	25.3	8.80	18.64	2.59	2.65	2.73	1.98							
				23.2	7.87			2.56	2.61	2.69	1.92						Potentially Deleterious	
	31.1	26.6	22.2	17.7	29.8	13.58	18.08	2.58	2.65	2.72	2.05						Innocuous	Inn
	51.9	42.2	33.2	25.9			21.85											
	28.5	18.7	13.9	11.3			30.13								2.69	3.9		
	22.9	14.9	9.5	6.5	25.0	13.79	30.23											
				26.5	2.88													
				27.9	11.19			2.56	2.61	2.70	1.99						Innocuous	

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LOCATION				AGGREGATE USE
AGGREGATE		ALKALI REACTIVITY (ASTM C 289)		
GRAVITY	PERCENT ABSORPTION			
APPAR- ENT			CA	
2.77	1.96	Potentially Deleterious		IIf
				Ic IIf
				Icr
		Innocuous	Innocuous	Ic IIf
				IIf
2.69	3.9			IIf
				IIf
				Ic IIf
				IIf
				Icr
				Icr
				IIf
		Innocuous		Ic

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - DMO

TABLE
A-1
PAGE 2 OF 9

FUGRO NATIONAL INC.

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	PERCENT GRAVEL
26	DLCDDP-A26	Dry Lake Valley	Vu	Welded Tuff			
27	DLCDDP-A27	Dry Lake Valley	Vu	Rhyolite			
28	DLCDDP-A28	Dry Lake Valley	Aafs	Gravelly Sand	SP	T	35
29	DLCDDP-A29	Highland Range	Ls	Limestone			
30	DLCDDP-A30	Dry Lake Valley	Aol	Sandy Gravel	GP		
31	DLCDDP-A31	Dry Lake Valley	Aaf	Gravelly Sand	SP	10	45
32	DLCDDP-A32	Pahranagat Valley	Aol	Gravelly Sand	SP		
33	DLCDDP-A33	Pahranagat Valley	Aol	Sandy Gravel	GP		
34	DLCDDP-A34	Pahroc Valley	Vu	Rhyolite			
35	DLCDDP-A35	Pahroc Valley	Su	Sandstone			
36	DLCDDP-A36	Pahroc Valley	Ls	Limestone			
37	DLCDDP-A37	Pahroc Valley	Aafs	Sandy Gravel	GP	5	70

FIELD OBSERVATIONS															
LAND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (A)							
	GRAVEL	SAND	FINES					3"	1½"	¾"	¾"	NO. 4	NO. 8	NO. 16	
T	35	60	5	None	Hard	Slight	Volcanic Glass and Pumice								
					Mod. Hard	Slight	Volcanic Glass and Pumice								
							Volcanic Glass, Ash, Caliche Nodules								
					Hard	Slight	None								
10	45	55	T	None			<5% Chert, Caliche Coatings	90.3	72.6	51.7	35.9	25.7			
				None			5% Chert, Caliche, Volcanic Glass								
				None			Caliche Coatings and Low Density Mtls.	100	97.8	90.0	78.7	59.8	44.7	30.9	21
				None			10% Intermediate Volcanics, Chert, Caliche	80.5	58.4	38.4	25.0	16.5			
5	70	30	0	None	Mod. Hard	Moderate	Volcanic Glass, Pumice, Mica								
					Hard	Slight	None								
					Hard	Slight	<5% Chert								
							<5% Chert								

LABORATORY TEST DATA

PASSING (ASTM C 136)						ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								RE (ASTM C 114)
									COARSE AGGREGATE				FINE AGGREGATE				
									SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
									BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT		
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT	PERCENT ABSORPTION	BULK	BULK SSD	APPAR- ENT	PERCENT ABSORPTION	CA	
							CA	FA									
						27.3		1.91									
						24.3		4.14	2.68	2.70	2.74	0.71					
7	30.9	20.9	12.4	7.5	4.6	34.7	18.15	35.30	2.45	2.53	2.66	3.31				Potential Deleterious	
						23.9		3.86	2.54	2.58	2.66	1.81					
						35.5		3.64	2.63	2.65	2.69	0.81					

				AGGREGATE USE
ION		ALKALI REACTIVITY (ASTM C 289)		
AGGREGATE				
RAVITY	PERCENT ABSORPTION	CA	FA	
APPAR- ENT				IIcr
				IIcr
				IIIf/c
				Icr
				Ic
				IIIf
				IIIf/c
		Potentially Deleterious	Deleterious	IIIf/c
				Ic
				IIcr
				Icr
				IIcr
				IIc/f

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - DND

TABLE
A-1
PAGE 3 OF 9

FUGRO NATIONAL INC.

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DIST. MATERIAL THIN
						GRAVEL	
38	DLCDDP-A38	Dry Lake Valley	Do	Dolomite			
39	DLCDDP-A39	Dry Lake Valley	Vu	Andesite			
40	DLCDDP-A40	Dry Lake Valley	Qtz	Quartzite			
41	DLCDDP-A41	Dry Lake Valley	Aol	Gravelly Sand	SP	T	25
42	DLCDDP-A42	Dry Lake Valley	Aafs	Gravelly Sand	SP	0	30
43	DLCDDP-A43	Dry Lake Valley	Aafg	Sandy Gravel	GP		
44	DLCDDP-A44	Dry Lake Valley	Aafs	Silty Sandy Gravel	GM		
45	DLCDDP-A45	Antelope Canyon	Aal	Gravelly Sand	SP	T	45
46	DLCDDP-A46	Antelope Canyon	Qtz	Quartzite			
47	DLCDDP-A47	Muleshoe Valley	Ls	Limestone			
48	DLCDDP-A48	Antelope Canyon	Aal	Sandy Gravel	GP		
49	DLCDDP-A49	Dutch John Mountains	Aaf	Silty Gravel	GM		
50	DLCDDP-A50	Bristol Pass	Aaf	Gravelly Sand	SP	T	40

FIELD OBSERVATIONS

DISTRIBUTION OF
MATERIAL FINER
THAN COBBLES,
PERCENT

GRAVEL

SAND

FINES

PLASTICITY

HARDNESS

WEATHERING

DELETERIOUS
MATERIALS

SIEVE ANALYSIS, PERCENT PASSING (ASTM)

3"

1½"

¾"

¾"

NO.
4NO.
8NO.
16NO.
30

				Hard	Slight	Calcite Veins								
				Hard	Slight	Volcanic Glass, Pumice, Vesicles								
				Very Hard	Fresh	None								
25	75	0	None			Chert, Volcanic Glass, Caliche Coatings								
30	70	T	None			Volcanic Glass, Caliche Coatings								
			None			Volcanic Glass, Caliche Coatings	79.6	59.3	46.2	39.0	34.4			
			None			15% Ash Fragments and Clay Lumps	94.7	93.2	81.7	63.9	45.8	36.1	29.1	24.8
45	55	T	None			Low Density Material								
				Very Hard	Slight	None								
				Hard	Slight	Calcite Veins								
			None			Caliche Coatings, Volcanic Ash	97.8	83.7	70.0	60.8	52.5	45.4	35.1	23.
			None			10% Chert, Caliche Coatings		100	96.4	73.7	38.2	28.2	23.5	21.
40	60	T	None			Chert, Pumice								

LABORATORY TEST DATA

(ASTM C 136)				ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)				
							COARSE AGGREGATE				FINE AGGREGATE								
							SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION					
NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT		CA	FA			
				64.9															
				20.4	11.97		2.54	2.59	2.67	1.96									
24.8	21.6	18.8	15.8	27.8	8.26	18.16													
23.1	12.0	6.9	4.7	22.7		20.33													
21.1	20.3	19.6	17.6	25.6	5.10	8.00	2.63	2.67	2.75	1.56	2.56	2.61	2.68	1.79					
				27.5	5.30		2.60	2.65	2.73	1.84									

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				AGGREGATE USE
ION		ALKALI REACTIVITY (ASTM C 289)		
NEGATIVE				
WITY	PERCENT ABSORPTION	CA	FA	
PPAR- ENT				
				IIcr
				IIcr
				IIcr
				IIIf
				IIIf/c
				Ic
				Ic IIIf
				IIf/c
				IIcr
				IIcr
				IIc/f
2.68	1.79			Ic/f
				Ic IIIf

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
DRY LAKE, MOLESHOE, DELAMAR, AND PANROC VALLEYS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMD

TABLE
A-1
PAGE 4 OF 9

FUGRO NATIONAL INC.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	GRAVEL
51	DLCDP-A51	Delamar Valley	Ls	Limestone			
52	DLCDP-A52	Delamar Valley	Vu	Ignimbrite			
53	DLCDP-A53	Delamar Valley	Vu	Rhyolite			
54	DLCDP-A54	Delamar Valley	Vu	Andesite			
55	DLCDP-A55	Delamar Valley	Vu	Rhyolitic Tuff			
56	DLCDP-B1	Muleshoe Valley	Ls	Limestone			
57	DLCDP-B2	Sidehill Valley	Ls	Limestone			
58	DLCDP-B3	Steward Spring	Ls	Limestone			
59	DLCDP-B4	Muleshoe Valley	Ls	Limestone			
60	DLCDP-B5	Muleshoe Valley	Vu	Andesite			
61	DLCDP-B6	Muleshoe Valley	Vu	Welded Tuff			
62	DLCDP-B7	Miller Summit	Vu	Welded Ash Flow			

FIELD OBSERVATIONS

PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASS'NG (ASTM)							
	GRAVEL	SAND	FINES					3"	1½"	¾"	¾"	NO. 4	NO. 8	NO. 16	NO. 30
					Hard	Slight	<5% Chert								
					Hard	Slight	Volcanic Glass, Low Density Materials								
					Hard	Slight	Volcanic Glass, Low Density Materials								
					Hard	Slight	Volcanic Glass								
					Mod. Hard	Moderate	Volcanic Glass, Pumice, Vesicles								
					Hard	Slight	None								
					Very Hard	Fresh	None								
					Very Hard	Fresh	Chert								
					Hard	Slight	Chert								
					Very Hard	Slight	Volcanic Glass								
					Hard	Slight	Volcanic Glass, Pumice								
					Hard	Slight	Volcanic Glass								

NO. 8	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR-ENT	PERCE ABSORP	BULK	BULK SSD	APPAR-ENT	PERCE ABSORP	CA
						CA	FA									
					62.5											Potentially Deleterious
					35.2	5.61		2.67	2.68	2.70	0.47					

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ABSORPTION	ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
	CA	FA	
Potentially Deleterious			IICr
			IICr
			IICr
			IICr
			IICr
			Icr
			IICr
			IICr
			IICr
			IICr
			IICr

**FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA**
 DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS

MX SITING INVESTIGATION
 DEPARTMENT OF THE AIR FORCE - DMO

TABLE
A-1
 PAGE 5 OF 9

FUGRO NATIONAL INC.

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT
63	DLCDP-B8	Miller Summit	Ls	Limestone		
64	NV-R-27	Chief Range	Au	Silty Sand	SP-SM	5
65	NV-R-28	Chief Range	Au	Gravelly Sand	SP	35
66	NV-R-30	Pioche Hills	Aaf	Sandy Gravel	GP-GC	60
67	NV-R-31	Lake Valley	Aaf	Clayey Sanduff	SC-SM	5
68	NV-R-32	Lake Valley	Vu	Rhyolite		
69	NV-R-33	Grassy Mountain	Aaf	Sandy Gravel	GP	
70	NV-R-85	Hiko Range	Cau	Limestone		
71	NV-R-86	Pahranagat Valley	Au	Silty Sand	SM	20
72	NV-R-87	Pahranagat Valley	Aal	Silty Sand	SM	25
73	NV-R-88	Pahranagat Valley	Au	Silty Sandf	SP/SW	5
74	NV-R-89	Pahranagat Valley	Aaf	Silty Sand	SP-SM	10
75	NV-R-90	Pahranagat Valley	Vu	Silicic Tuff		

SAND/GR COBBLES
PERCENT

FIELD OBSERVATIONS

DISTRIBUTION OF
MATERIAL FINER
THAN COBBLES,
PERCENTGRAVEL
SAND
FINES

PLASTICITY

HARDNESS

WEATHERING

DELETERIOUS
MATERIALS

SIEVE ANALYSIS, PERCENT PASSING (A)

3" 1½" ¾" ¾" NO. 4 NO. 8 NO. 16 NO. 30

Very
Hard

Slight

Chert

95% Glassy
Volcanics40% Glassy
VolcanicsChert, Caliche,
Clay80% Glassy
Volcanics

Glassy

Chert, Caliche

Chert

5% Glassy
Volcanics,
Caliche Coatings95% Glassy
Volcanics85% Glassy
Volcanics100% Glassy
Volcanics

Glassy

100

92.7

80.5

62.3

49.2

42.0

37.3

30

LABORATORY TEST DATA

PASSING (ASTM C 136)					ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALK REACT (ASTM)
								COARSE AGGREGATE				FINE AGGREGATE				
								SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT		CA

DRY

DEF

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	STR
							INTER THAN GRAVEL
76	NV-H-9	Chief Mountains	Qtz	Quartzite			
77	NV-H-10	Bristol Range	Cau	Limestone			
78	NV-H-11	Bristol Range	Cau	Limestone			
79	NV-H-15	Bristol Range	Cau	Limestone			
80	NV-H-16	Grassy Mountain	Cau	Limestone			
81	NV-H-17	Dutch John Mountain	Cau	Limestone			
82	NV-LN-1	Pahrnagat Valley	Au	Gravelly Sand	SP		
83	NV-LN-3	Delamar Mountains	Su	Sandy Gravel	GP		
84	DL-T-1	Coyote Wash	Aals	Silty Sand	SP-SM		
85	DL-T-2	Dry Lake Valley	Aals	Silty Sand	SP-SM		
86	DL-T-3	Dry Lake Valley	Aafs	Gravelly Sand	SP		
87	DL-T-4	Dry Lake Valley	Aafs	Silty Sand	SP-SM		
88	DL-T-5	Dry Lake Valley	Aafs	Gravelly Sand	SP		

FIELD OBSERVATIONS

DISTRIBUTION OF
MATERIAL FINER
THAN COBBLES,
PERCENT

GRAVEL
SAND
FINES

PLASTICITY

HARDNESS

WEATHERING

DELETERIOUS
MATERIALS

SIEVE ANALYSIS, PERCENT PASSING (ASTM)

3" 1½" ¾" 3/8" NO. 4 NO. 8 NO. 16 NO. 30

None

Dolomitic

Dolomitic

Chert

1 to 2% Chert

1 to 2% Chert

100 96.9 91.2 80.2 62 45.8 30.4

100 99.1 89.2 63.1 45.5 35.4 32.2

100 96.3 88 79.3 68.7⁸ 33⁸

94.2 82.8 70.6 60.8⁸ 43.4⁸

100 95 82 76 70⁸ 44⁸

100 94.5 90.3 82 72⁸ 45.3⁸

100 90 79 61 40⁸ 20⁸

LABORATORY TEST DATA

(ASTM C 136)				ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)				
							COARSE AGGREGATE				FINE AGGREGATE								
							SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION					
NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT						
					CA	FA								CA	FA				
	9.3	5.6	3.7	22.0	6.42	6.38		2.43				2.53							
	2.5	1.1	0.7	19.6	2.41	2.70													
33 [°]		14.7	10.7									2.62							
43.4 [°]		20.2	13.2									2.67							
44 [°]		7	3																
45.3 [°]		22.7	16.7									2.66							
20 [°]		10	8									2.64							

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ION	AGGREGATE		ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
	AVITY	PERCENT ABSORPTION			
	APPAR- ENT		CA	FA	
					IIcr
					IIcr
					IIcr
					IIcr
					IIcr
					IIcr
					If/c
					Ic/f
					IIIf
					IIIf/c
					IIIf
					IIIf
					IIIf/c

FUGRO NATIONAL FIELD STATION AND SUPPLEMENTARY TEST DATA DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - DMO	TABLE A-1 PAGE 7 OF 9
FUGRO NATIONAL INC.	

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	DIST. MAT. TH.
							GRAVEL
89	DL-T-6	Dry Lake Valley	Aals	Silty Sand	SM		
90	DL-T-7	Dry Lake Valley	Aals	Silty Sand	SP-SM		
91	DL-T-8	Dry Lake Valley	Aafs	Silty Sand	SM		
92	MS-T-1	Muleshoe Valley	Aafs	Sandy Silt	ML		T
93	MS-T-2	Muleshoe Valley	Aals	Silty Sand	SM		0
94	MS-T-3	Muleshoe Valley	Aals	Sandy Silt	ML		T
95	MS-T-4	Muleshoe Valley	Aafs	Gravelly Sand	SM		30
96	MS-T-5	Muleshoe Valley	Aafs	Gravelly Sand	SP-SM		18
97	MS-T-6	Muleshoe Valley	Aals	Silty Sand	SM		20
98	P-T-2	Pahroc Valley	Aafs	Silty Sand	SM		5
99	P-T-4	Pahroc Valley	Aafs	Gravelly Sand	SM		20
100	P-T-6	Pahroc Valley	Aafs	Gravelly Sand	SP-SM		25
101	DM-T-2	Delamar Valley	Aafs	Sandy Gravel	GP		70

FIELD OBSERVATIONS								SIEVE ANALYSIS, PERCENT PASSING (A)							
SAND/GRAND OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS								
	GRAVEL	SAND	FINES					3"	1½"	¾"	¾"	NO. 4	NO. 8	NO. 16	
										100	98	96.5	92 [#]		72
										99	93.5	85	70.5 [#]		3
									100	87.3	75.3	65	57 [#]		4
T	25	75													
O	65	35													
T	40	60													
30	55	15													
18	70	12													
20	60	20													
5	75	20													
20	60	20													
25	70	5													
70	25	5													

LABORATORY TEST DATA

[illegible]

DEPART

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	GRAVEL
102	DM-T-3	Delamar Valley	Aafs	Silty Sand	SP-SM		20
103	DM-T-4	Delamar Valley	Aafs	Gravelly Sand	SM		25
104	DM-T-5	Delamar Valley	Aafs	Silty Sand	SM		10
105	DM-T-6	Delamar Valley	Aafs	Gravelly Sand	SM		20
106	DM-T-7	Delamar Valley	Aolf	Sandy Silt	ML		0
107	DM-T-8	Delamar Valley	Aafs	Silty Sand	SM		5
108	DM-T-10	Delamar Valley	Aafs	Silty Gravel	GM		40

2

LABORATORY TEST DATA

[illegible]

DRY LAND

DEPART

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ALKALI
REACTIVITY
(ASTM C 289)

AGGREGATE
USE

CA

FA

II f

II f

II f

II f

III f

II f

II c/f

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
DRY LAKE, MULESHOE, DELAMAR, AND PANHOC VALLEYS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - DND

TABLE
A-1
PAGE 2 OF 2

FUGRO NATIONAL INC.

4

EXPLANATION OF EXISTING DATA

Existing data pertaining to aggregates were extracted from the State of Nevada Department of Highways. These reports are compilations of available site data from existing files and records and are intended to accurately locate, investigate, and catalog materials needed for highway construction. Explanations for column headings which appear in Table A-2, that have not been previously discussed in Table A-1, are given below:

<u>Column Heading</u>	<u>Explanation</u>
Site Number	State of Nevada Department of Highways pit or site number. Locations correspond to map numbers listed on this table and placed on Drawing 1.
Soundness Test	The testing of aggregates to determine their resistance to disintegration by saturated solutions of sodium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate information is not available from service records of the material exposed to actual weathering conditions.

MAP NUMBER	SITE NUMBER	DATA SOURCE	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL		
							> 6"	3-6"
109	LN15-1	Nevada Dept. of Highways	Pahranagat Valley	Au	Silty Gravel	GP-GM	5	10
110	LN15-2	Nevada Dept. of Highways	Pahranagat Valley	Au	Silty Gravel	GM-GC	3	
111	LN15-3	Nevada Dept. of Highways	Pahranagat Valley	Au	Silty Gravel	GP-GM	4	
112	LN15-4	Nevada Dept. of Highways	Pahranagat Valley	Aol	Silty Gravel	GM-GC	4	
113	LN15-7	Nevada Dept. of Highways	Pahranagat Valley	Au	Silty Gravel	GP-GM	4	
114	LN15-8	Nevada Dept. of Highways	Pahranagat Valley	Aol	Silty Gravel	GP-GM	9	
115	LN15-12	Nevada Dept. of Highways	Pahranagat Valley	Aol	Silty Gravel	GM	1	
116	LNRS-3	Nevada Dept. of Highways	Dry Lake Valley	Aolf	Silty Gravel	GP-GM	0	
117	LN24-2	Nevada Dept. of Highways	Delamar Mountains	Au	Clayey Gravel	GC	4	
118	LN02-5	Nevada Dept. of Highways	Pahranagat Valley	Aaf	Sandy Gravel	GP		10
119	LN02-7	Nevada Dept. of Highways	Pahranagat Valley	Au	Silty Gravel	GM		10
120	LN02-8	Nevada Dept. of Highways	Pahranagat Valley	Au	Sandy Gravel	GP		
121	LN02-9	Nevada Dept. of Highways	Pahranagat Valley	Au	Gravelly Sand	SP-SM		

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FUGRO NATIONAL INC LONG BEACH CA

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MX SITING INVESTIGATION. GEOTECHNICAL EVALUATION. AGGREGATE RES--ETC(U)

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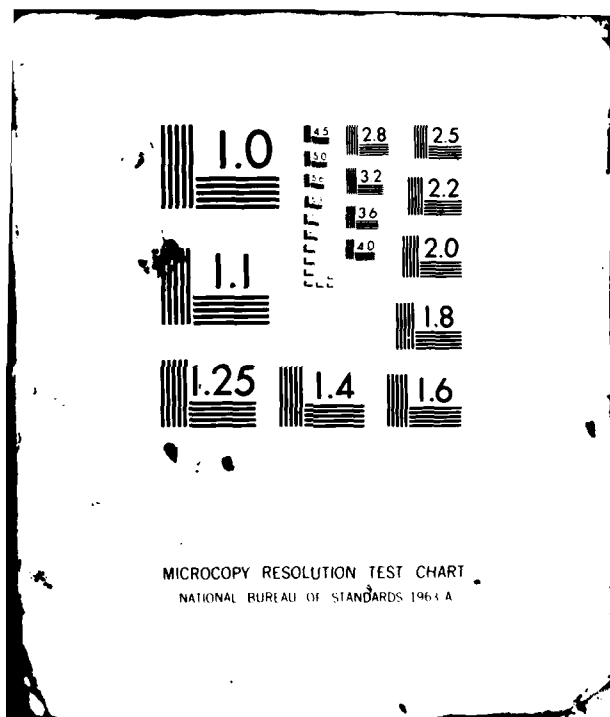
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SIEVE ANALYSIS

ABRASION TEST
(ASTM C 131)

SOUNDNESS
TEST
(ASTM C 88)

SPE

BUL

3-6"	1½"	1"	¾"	½"	¼"	⅜"	NO. 4	NO. 10	NO. 16	NO. 40	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT CA	LOSS FA	
10			26			49							4-13	23.1			
4			19			35							5-26	25.4			
5			28			48							2-20	25.4			
4			16			31							5-11	28.3			
4			12			24							4-12	36.9			
9			30			45							5-12	25.5			
1			6			10							5-16	35			
1			11			29							7-22	25			
6			18			26							1-68	34.8			
100	92	84	77	62			48	68	49	20	15	9	6	22	6.42	6.38	
100	81	61	48	31		21	16	15	13	9	5	4	3	23		2.97	2.
		100	100	89		81	65	50	41	22	17	11	7	28.7			
			100	85		74	62	48	38	20	16	11	7	31.2			

SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								PLASTICITY INDEX (ASTM D 423 AND D 424)	ALKALI REACTIVITY (ASTM C 289)	
COARSE AGGREGATE				FINE AGGREGATE						
SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT				
		2.65						NP		
		2.56						NP-16		
		2.65						NP		
		2.58						NP-9		
		2.51						NP		
		2.68						NP		
								NP		
		2.52						NP		
		2.52						NP-17		
		2.53								
2.76	2.78	2.81	0.65							
		2.56						NP		
		2.59						NP		

EXISTING TEST DATA
 DRY LAKE, MOLESHOE, DELAMAR, AND PAHROC VALLEYS

MX SITING INVESTIGATION
 DEPARTMENT OF THE AIR FORCE - DDD

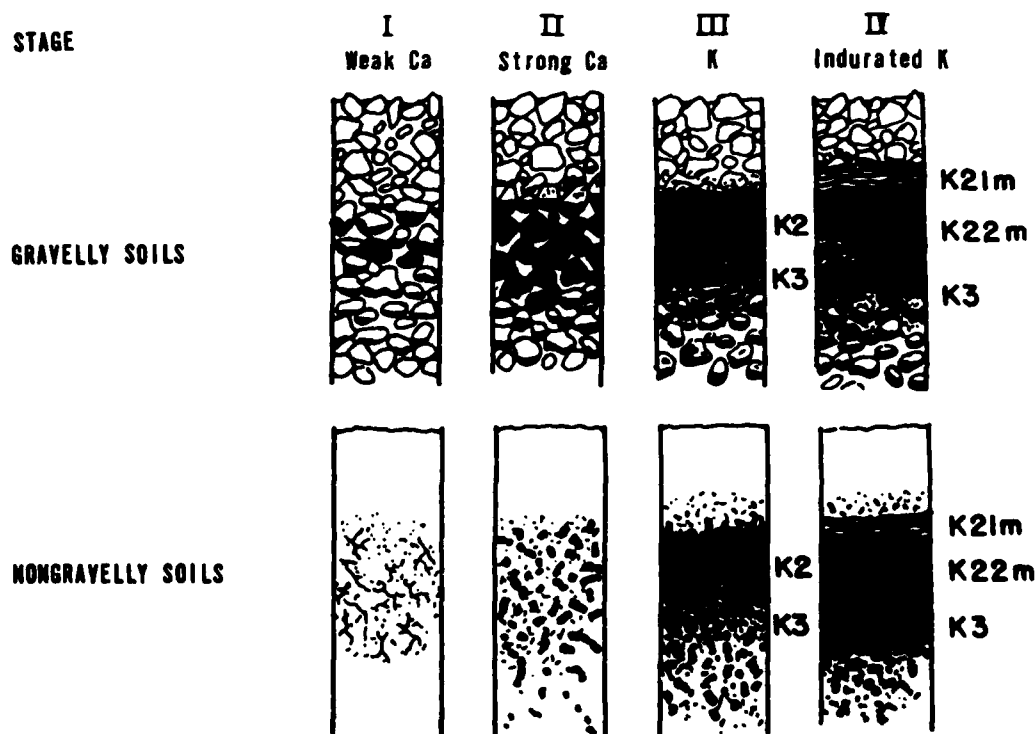
TABLE
 A-2
 PAGE 1 OF 1

FURRO NATIONAL INC.

APPENDIX B
Summary of Caliche Development

DIAGNOSTIC CARBONATE MORPHOLOGY

STAGE	GRAVELLY SOILS	NONGRAVELLY SOILS
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Laminar horizon overlying plugged horizon



Stages of development of a caliche profile with time. Stage I represents incipient carbonate accumulation, followed by continuous build-up of carbonate until, in Stage IV, the soil is completely plugged.

SUMMARY OF CALICHE DEVELOPMENT

Reference: Gile, L.H., Peterson, F.F., and Grossman, R.B., 1965, The K horizon: A master horizon of carbonate accumulation; Soil Science, v. 89, p. 74-82.

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - DMO

FIGURE
8-1

GUERO NATIONAL INC.

APPENDIX C

Unified Soil Classification System

Field Identification Procedures (Excluding particle larger than 3 in. and testing fractions on estimated weights)				Group Symbols		Typical Names		Information Required for Describing Soil		Laboratory Classification Criteria	
Coarse-grained soils More than half of material is larger than No. 200 sieve and (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than No. 4 sieve and (For visual classification, the No. 4 sieve may be used as equivalent to the No. 10 sieve)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical names; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse and fine fractions; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for GW Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils
Fine-grained soils More than half of material is smaller than No. 200 sieve and (The No. 200 sieve size is about the smallest particle visible to naked eye)	Sands More than half of coarse fraction is smaller than No. 4 sieve and (For visual classification, the No. 4 sieve may be used as equivalent to the No. 10 sieve)	Clean sands (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sand, little or no fines	Give typical names; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse and fine fractions; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for SW Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils
Highly Organic Soils	Silt and clay Liquid limit less than 50	Silt and clay Liquid limit less than 50	None to slight	ML	Inorganic silt and clay, very fine sand, fine sand, silty or clayey fine sand with slight plasticity	Give typical names; indicate degree and character of plasticity; maximum size of coarse grains; color; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for ML Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	None to slight	MH	Inorganic silt and clay, medium plasticity, silty or clayey medium plasticity, silty or clayey medium plasticity	Give typical names; indicate degree and character of plasticity; maximum size of coarse grains; color; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for MH Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	None to slight	CH	Inorganic silt and clay, high plasticity, silty or clayey high plasticity	Give typical names; indicate degree and character of plasticity; maximum size of coarse grains; color; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for CH Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	None to slight	OH	Inorganic silt and clay, very high plasticity, silty or clayey very high plasticity	Give typical names; indicate degree and character of plasticity; maximum size of coarse grains; color; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for OH Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	None to slight	PI	Peat and other highly organic soils	Give typical names; indicate degree and character of plasticity; maximum size of coarse grains; color; and other pertinent information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: 5% to 12% More than 12% GM, GP, GC, SM, SC Less than 5% GW, GP, SW, SP	Use grain size curve in identifying the fractions as given under field identification	Dual symbols Gravels with fines requiring use of dual symbols Above "A" line with P between 4 and 7 are borderline cases requiring use of dual symbols Below "A" line, with P greater than 7	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^3}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for PI Atterberg limits below 4 with P between 4 and 7 are borderline cases requiring use of dual symbols Atterberg limits below 5 "A" line, with P greater than 7	Plasticity index Plasticity chart for laboratory classification of fine grained soils

From Whistler, 1957.

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/4 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Moisture (Reaction to Shrinkage): After removing particles larger than No. 40 sieve size, prepare a pat of soil about the size of a golf ball. Add water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction changes to a lively consistency and becomes glossy. When the sample changes to a lively consistency and becomes glossy, when the sample surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Toughness (Consistency near plastic limit): After removing particles larger than No. 40 sieve size, a specimen of soil about the size of a golf ball is prepared. Add water if necessary to make the soil soft but not sticky. The specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and re-rolled repeatedly. During this process, the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached. After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles. The harder the lump is, the more plastic the soil. The toughness of the lump below the plastic limit indicates either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very red and spongy feel at the plastic limit.

Field Identification Procedure for Fine Grained Soils or Fractions

Dry Strength (Cracking Characteristics): After removing particles larger than No. 40 sieve size, mould a pat of soil about the size of a golf ball. Dry the soil by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. A typical high dry strength is characteristic of clays of the CH group. A typical low dry strength is characteristic of silts and silty clays. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

UNIFIED SOIL CLASSIFICATION SYSTEM

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - 000

TABLE
C-1

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APPENDIX D

Dry Lake, Muleshoe, Delamar, and Pahroc Valleys
Study Area Photographs



Older Lacustrine Deposit (Aolg), widely scattered within
Pahranagat Valley, southwest of the Pahroc Valley area;
Class I, coarse aggregate source (Field Station 30).

DRY LAKE, MULESHOE, DELAMAR, AND PAHROC
VALLEYS STUDY AREA PHOTOGRAPH

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FIGURE
D-1

UGRO NATIONAL, INC.



Sandstone member of the Simonson Dolomite (Do) located within Pahroc Valley in the southwestern portion of the study area; Class I, crushed rock aggregate source (Field Station 35).

DRY LAKE, MULESHOE, DELAMAR, AND PAHROC
VALLEYS STUDY AREA PHOTOGRAPH

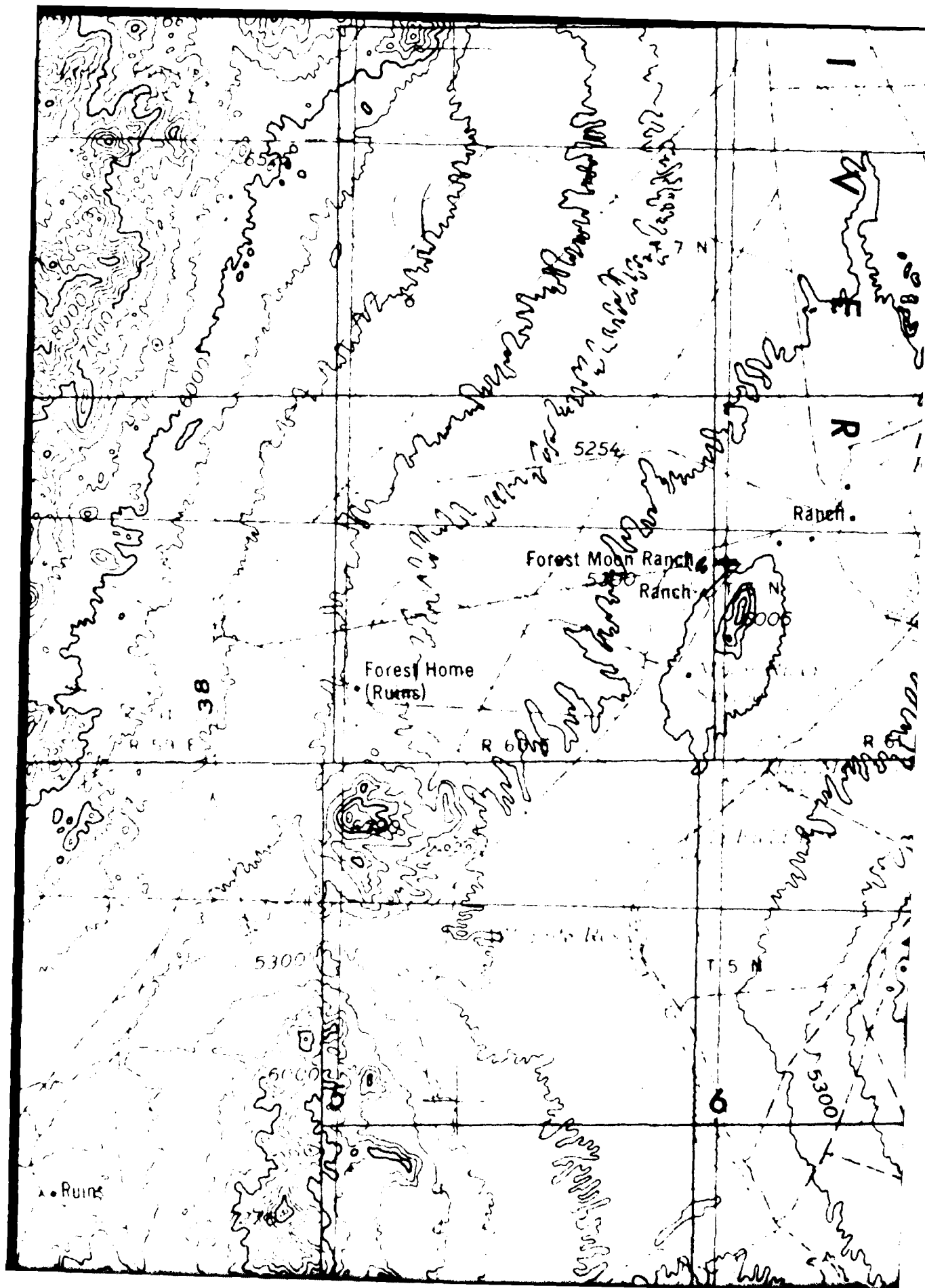
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - DMO

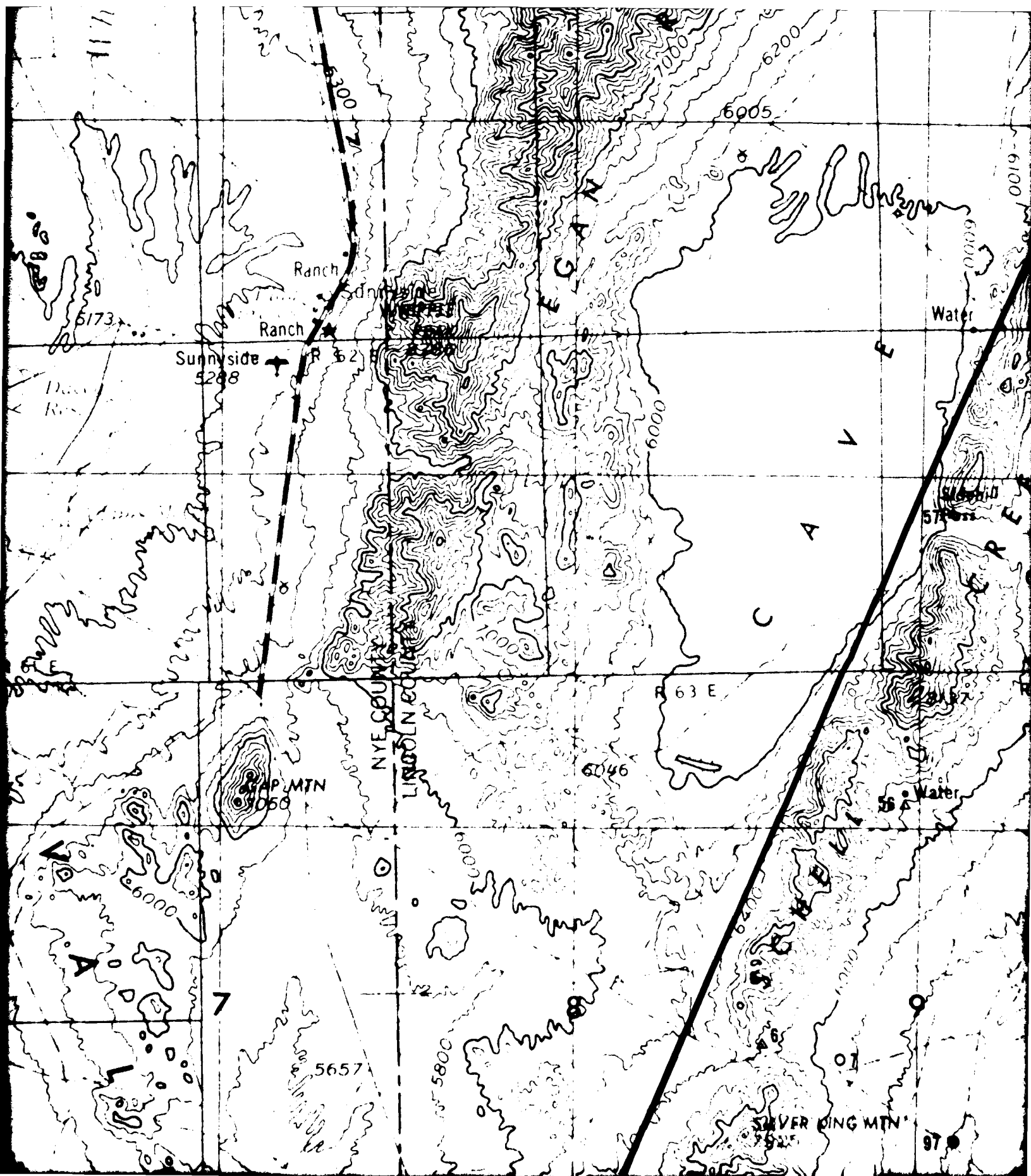
FIGURE
D-2

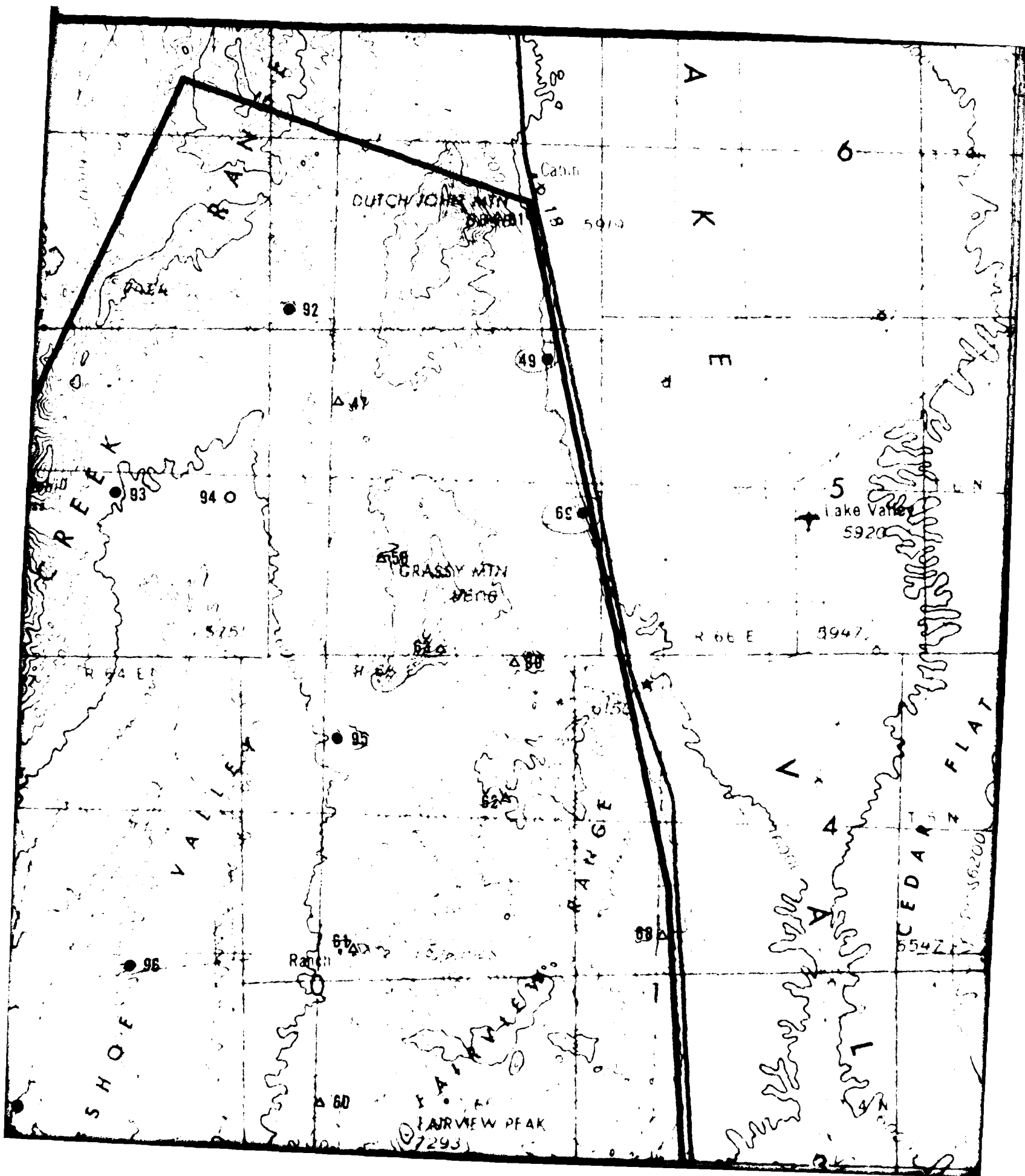
FUGRO NATIONAL, INC.

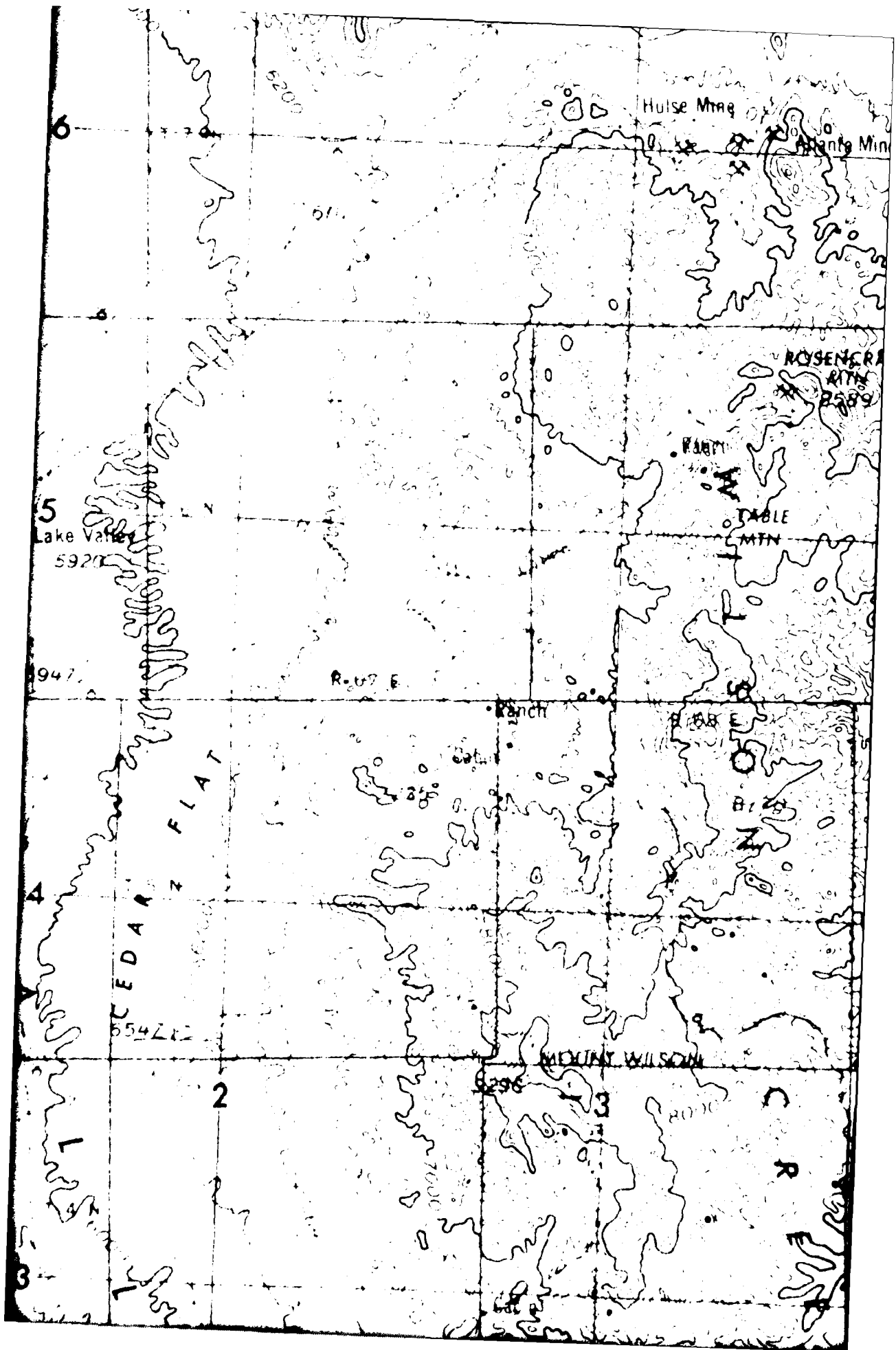
APPENDIX E

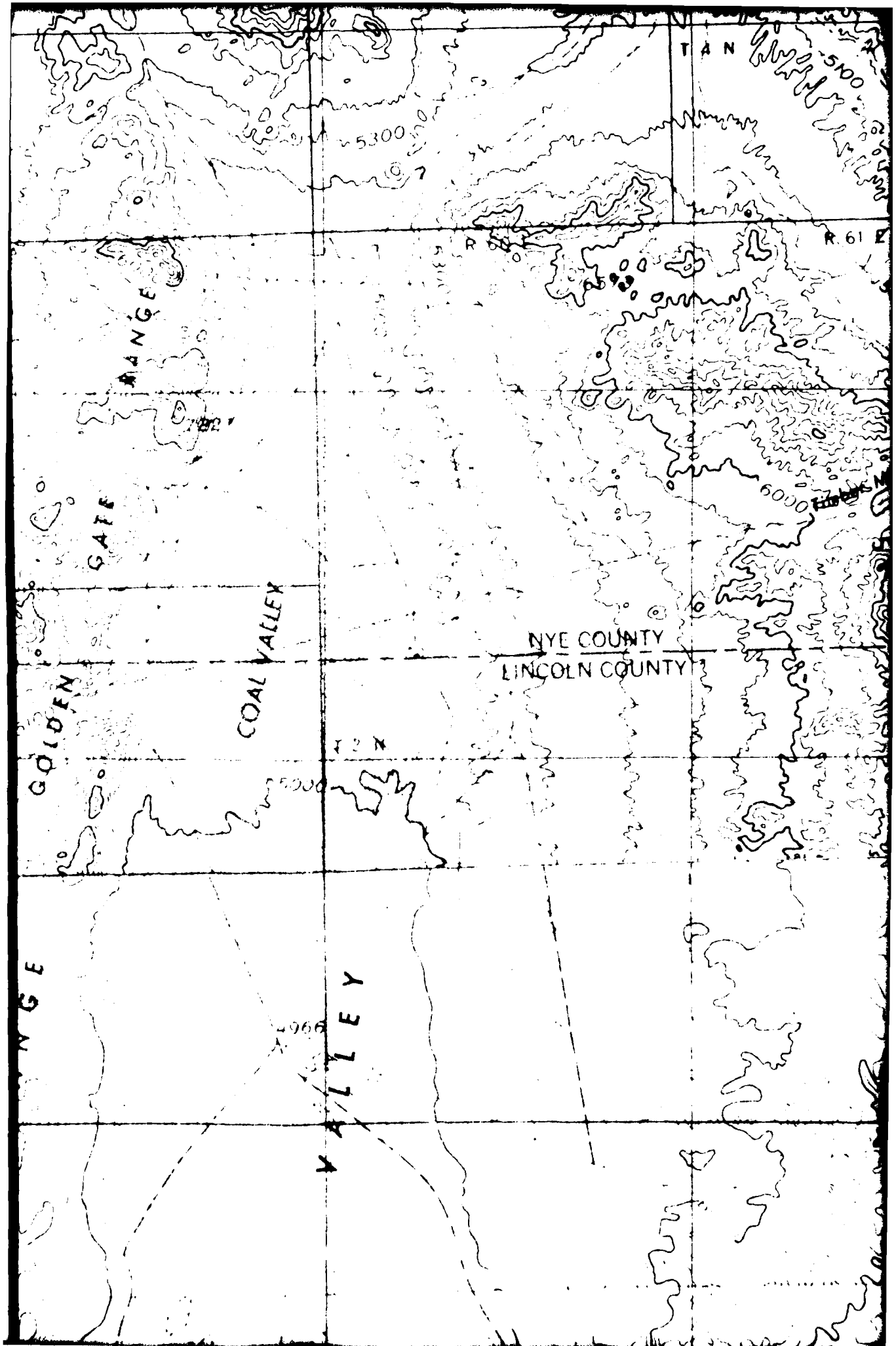
Fugro National Geologic Unit Cross Reference

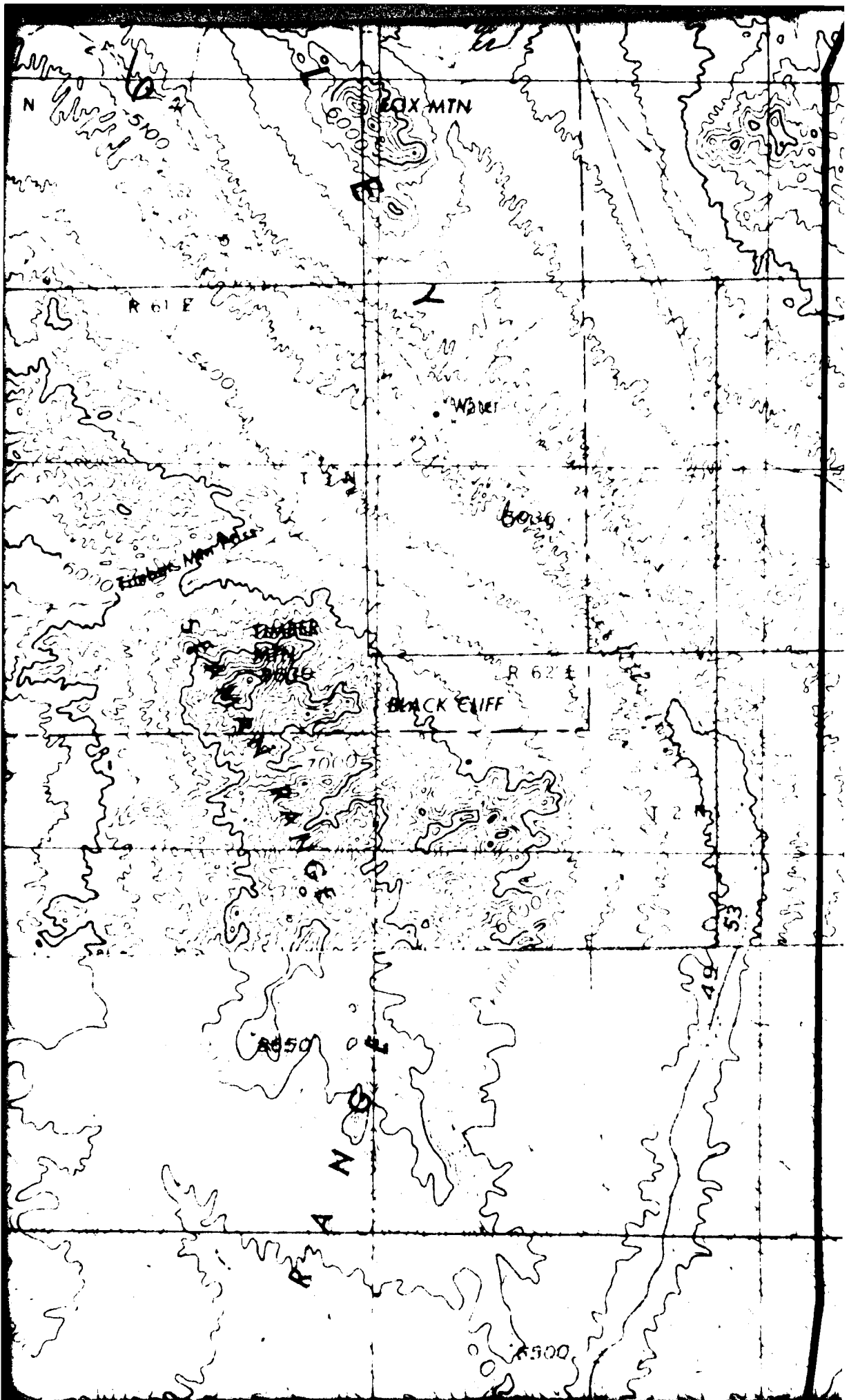


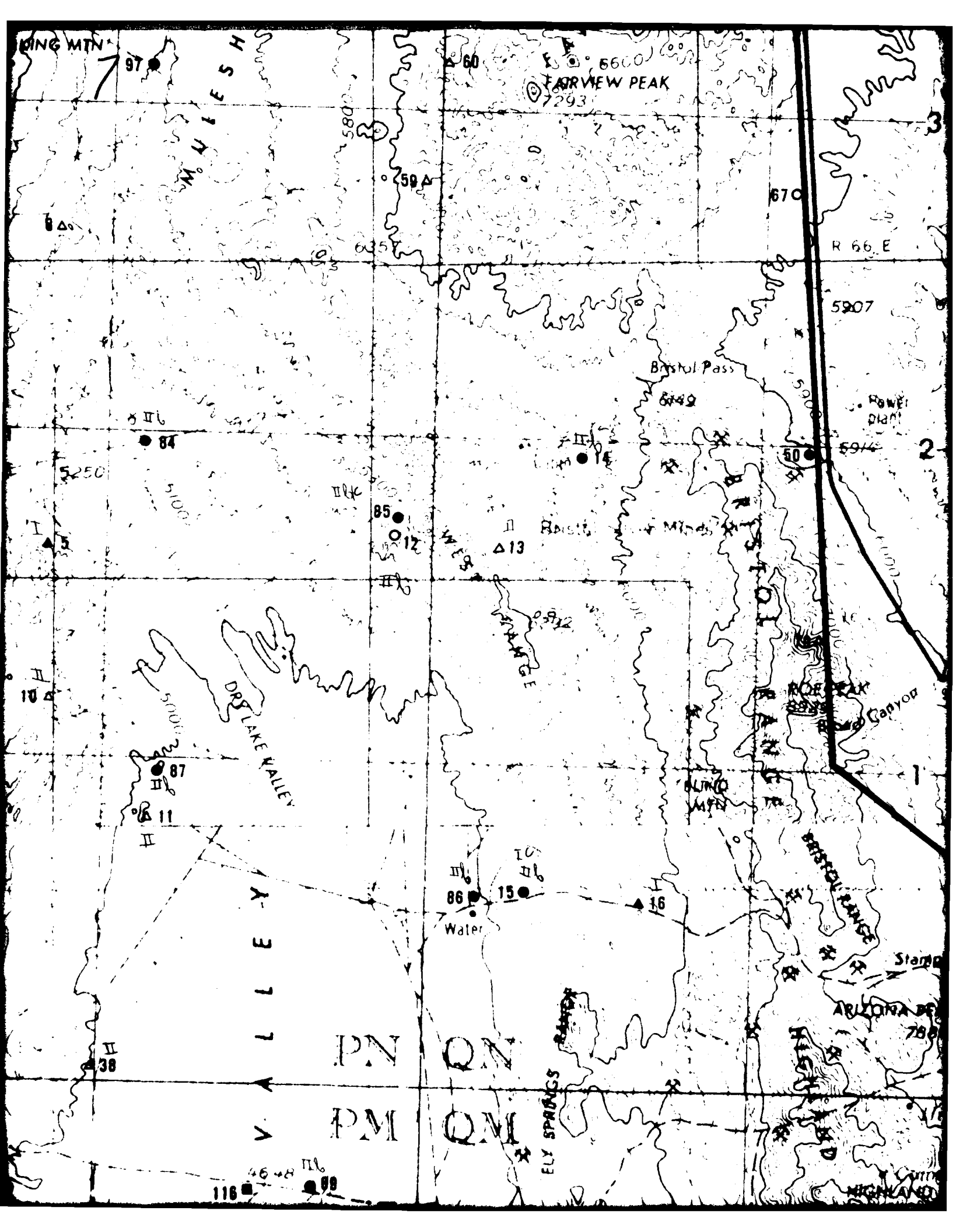


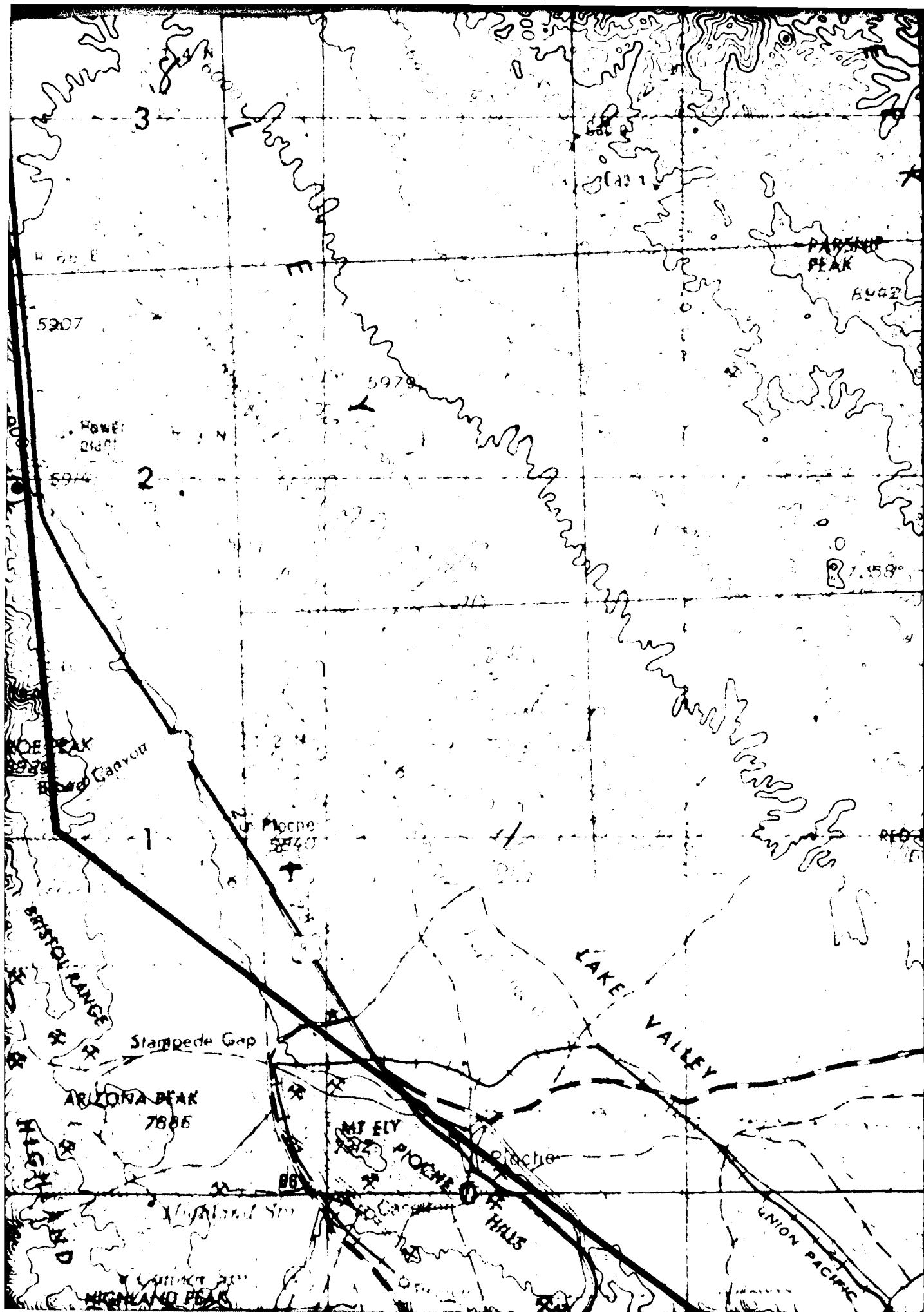


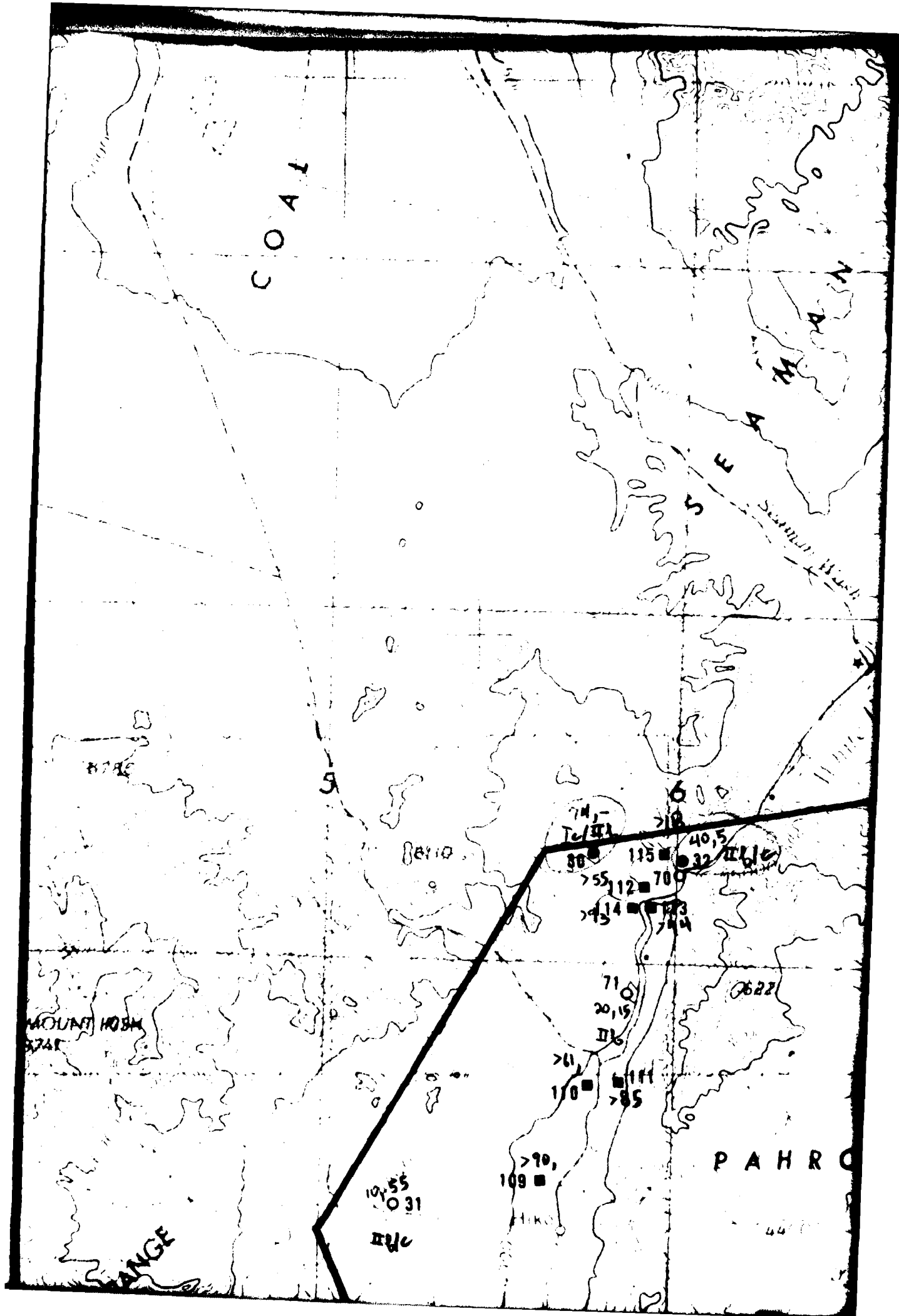


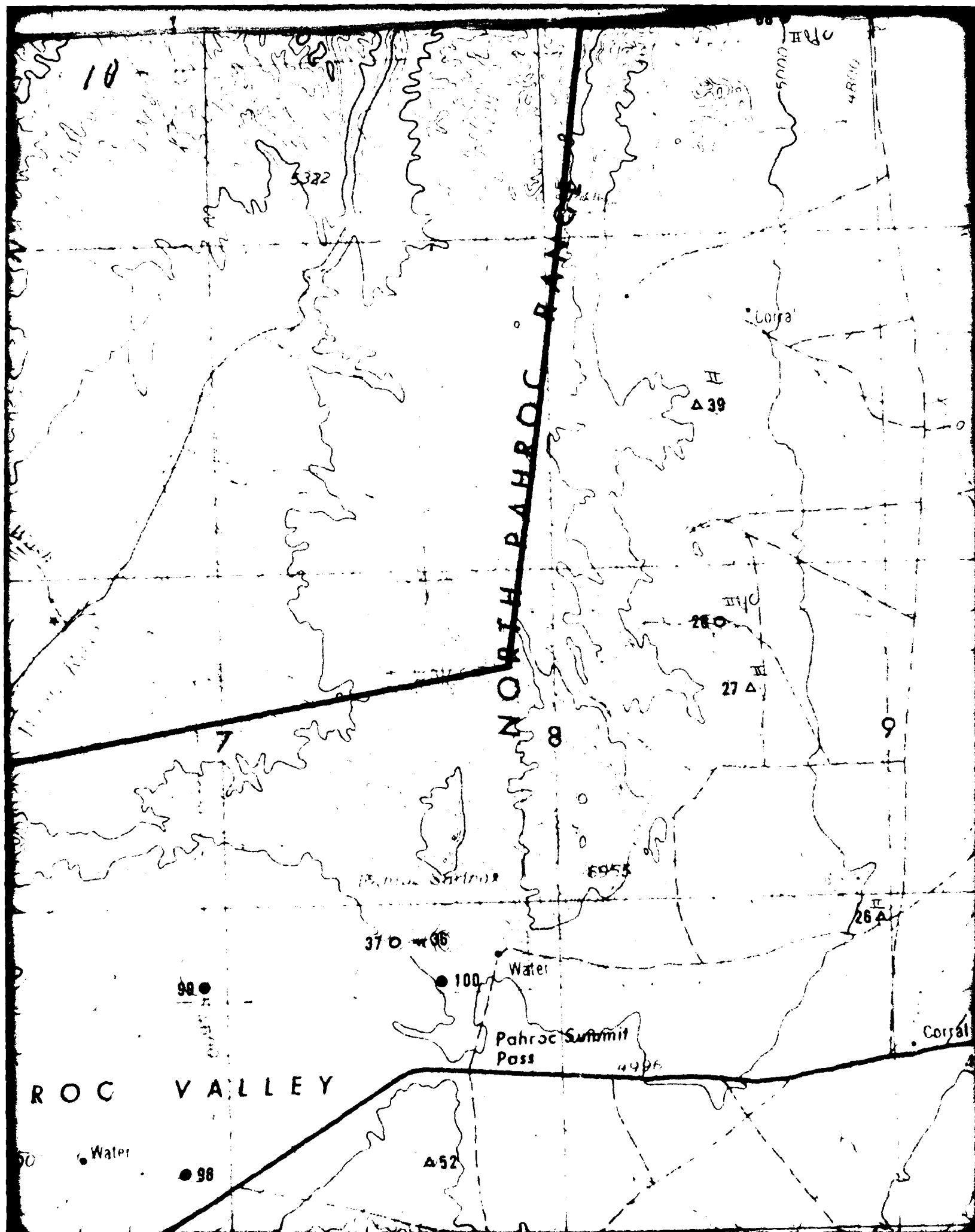


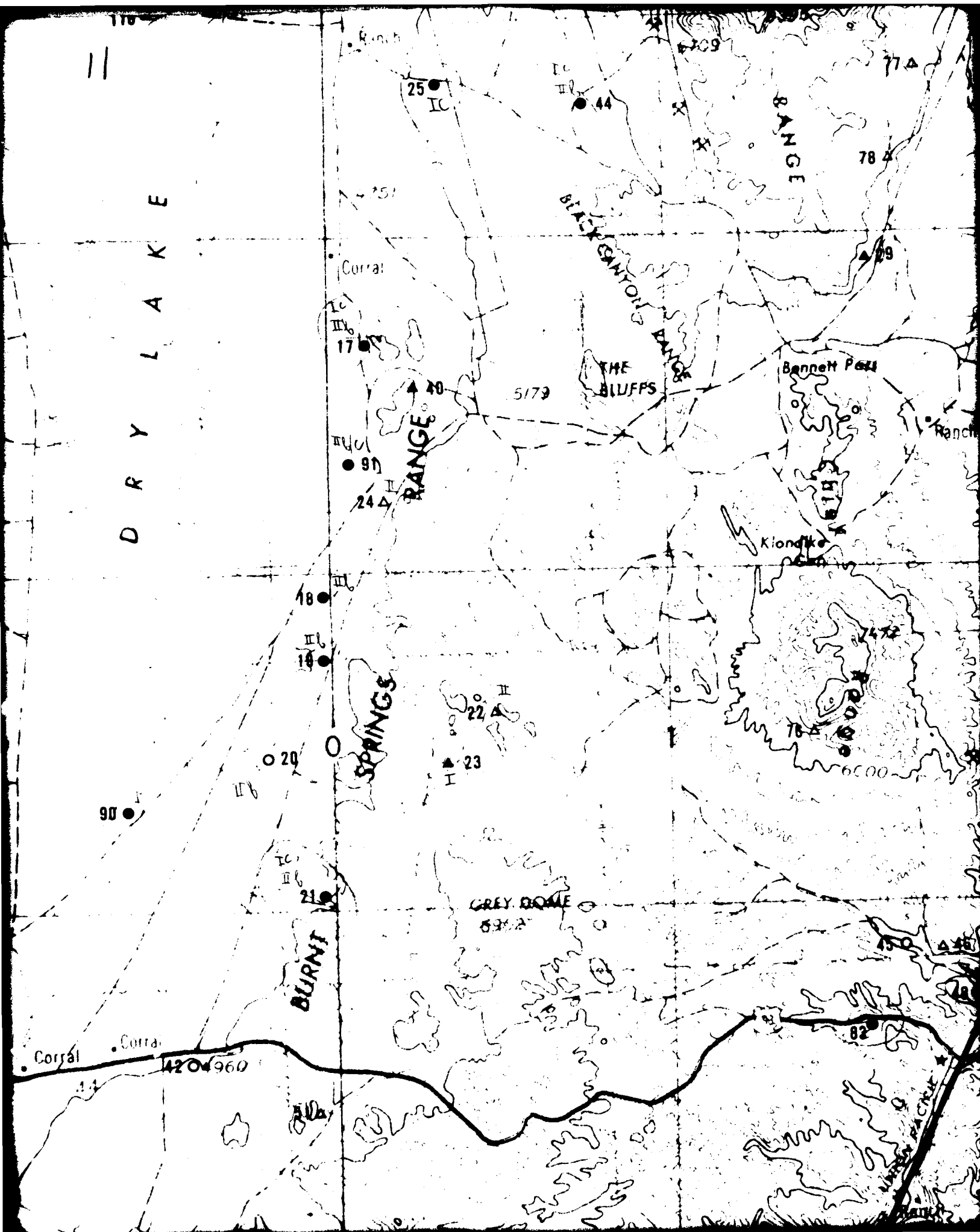


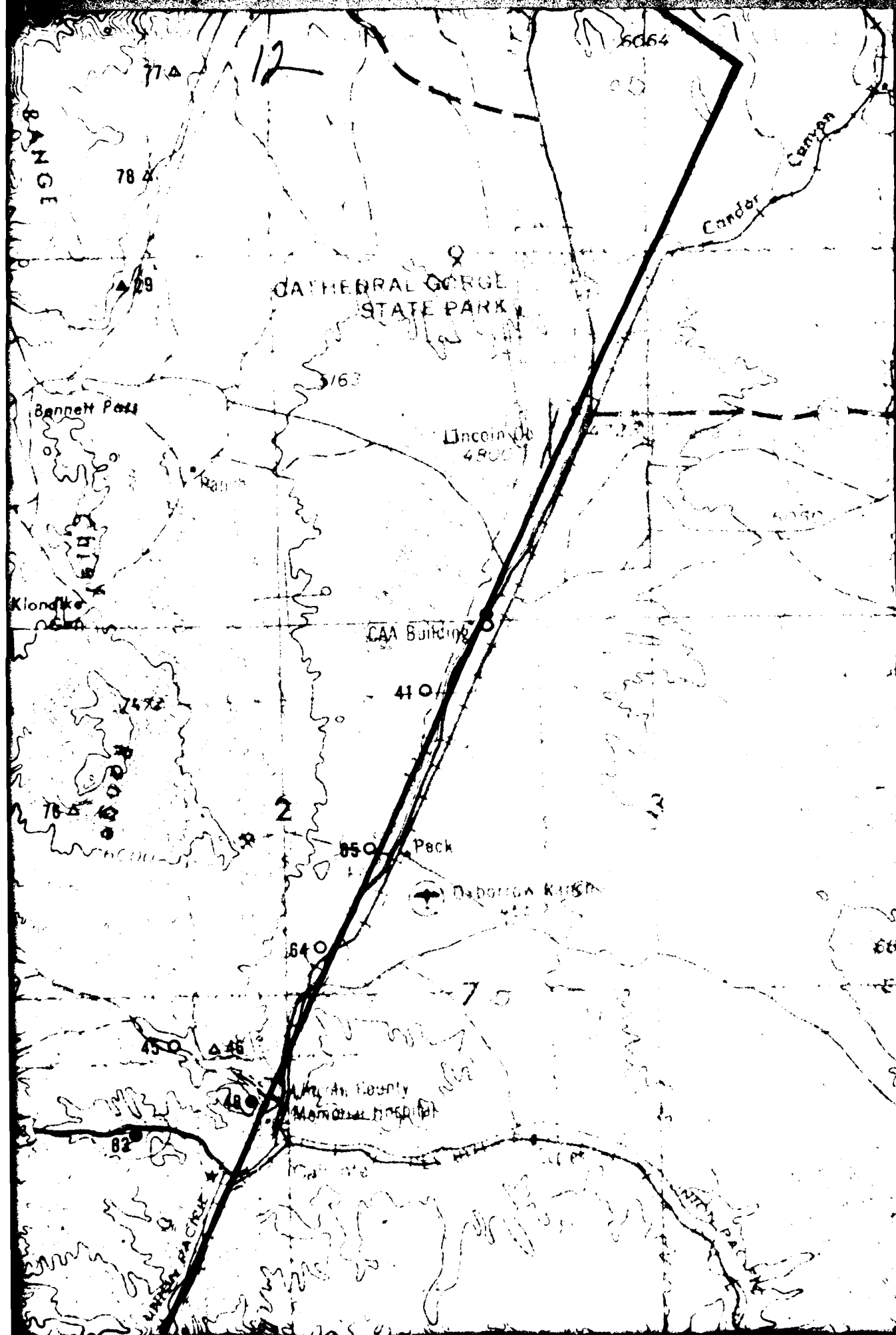


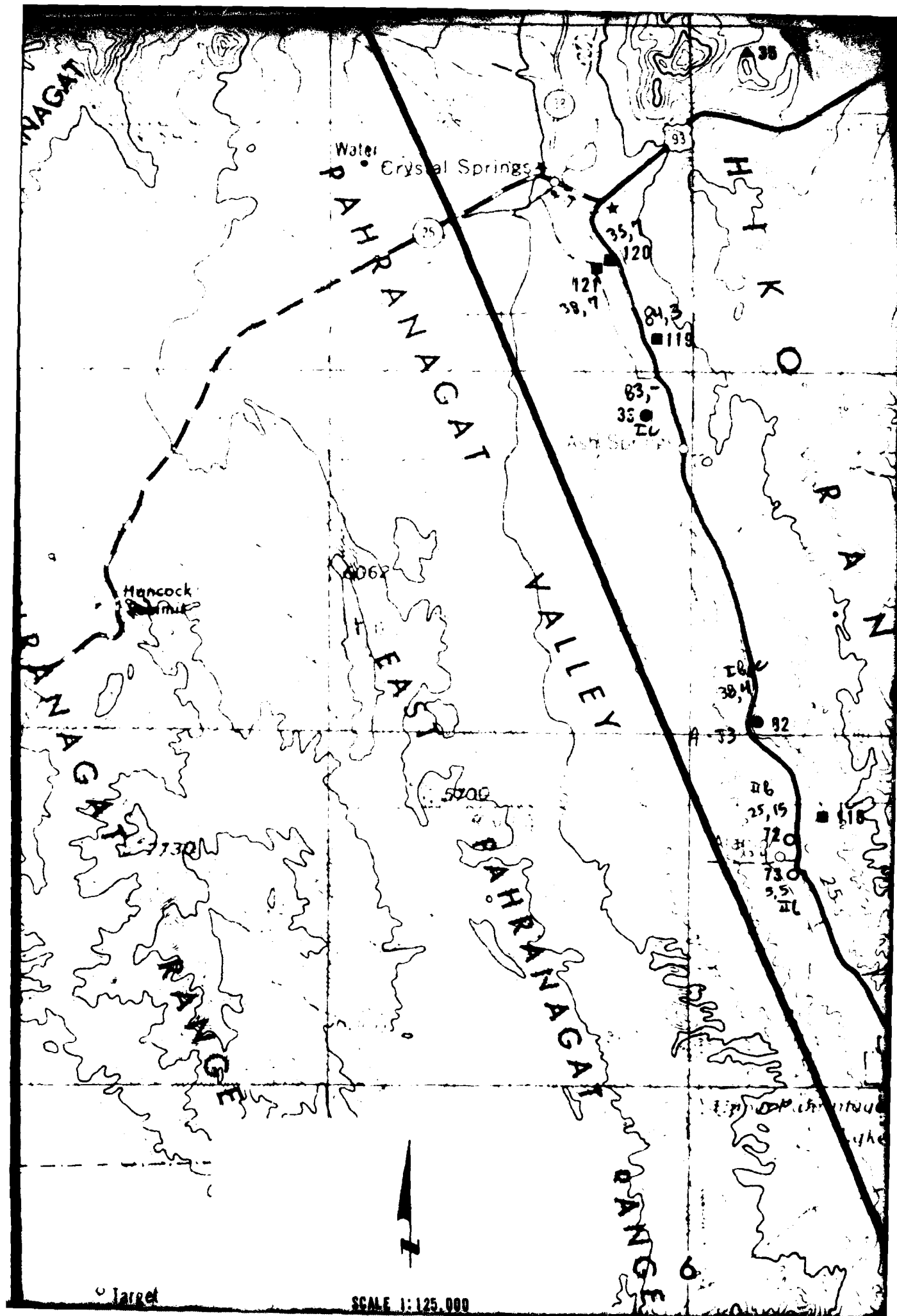






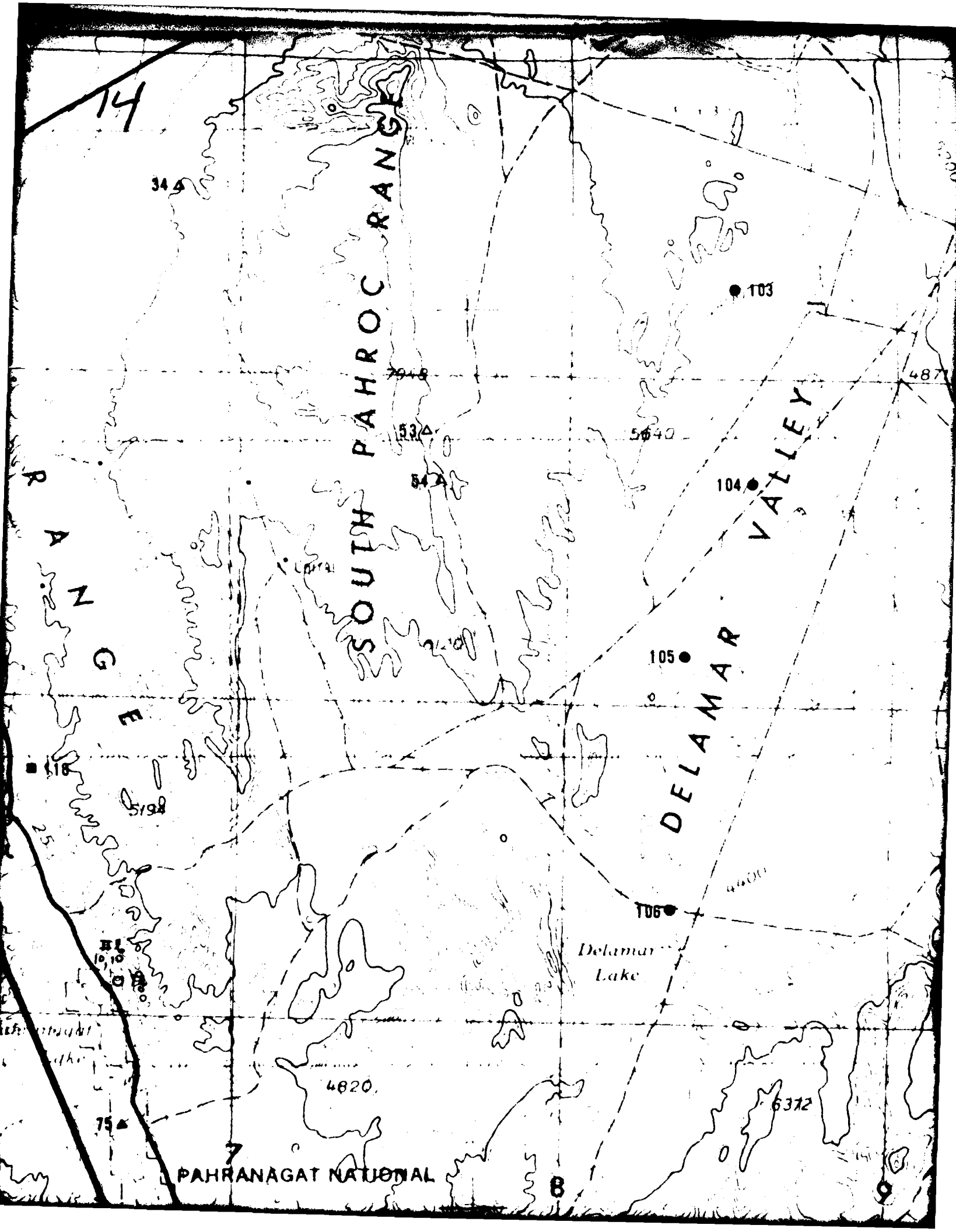






Target

SCALE 1:125,000



15

Unat.

● 101

■ 117

● 102

● 43

● 108

● 107

△ 55

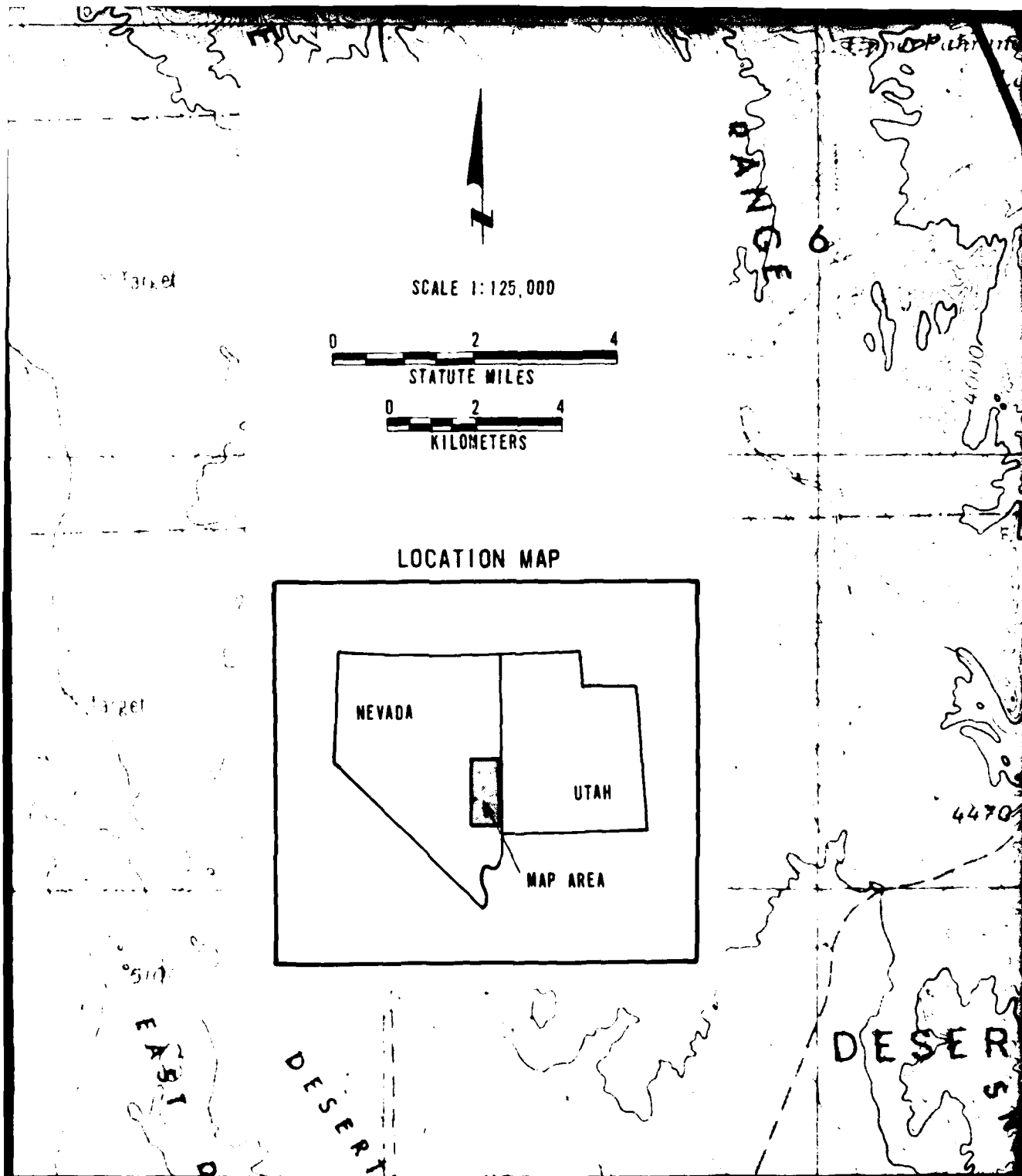
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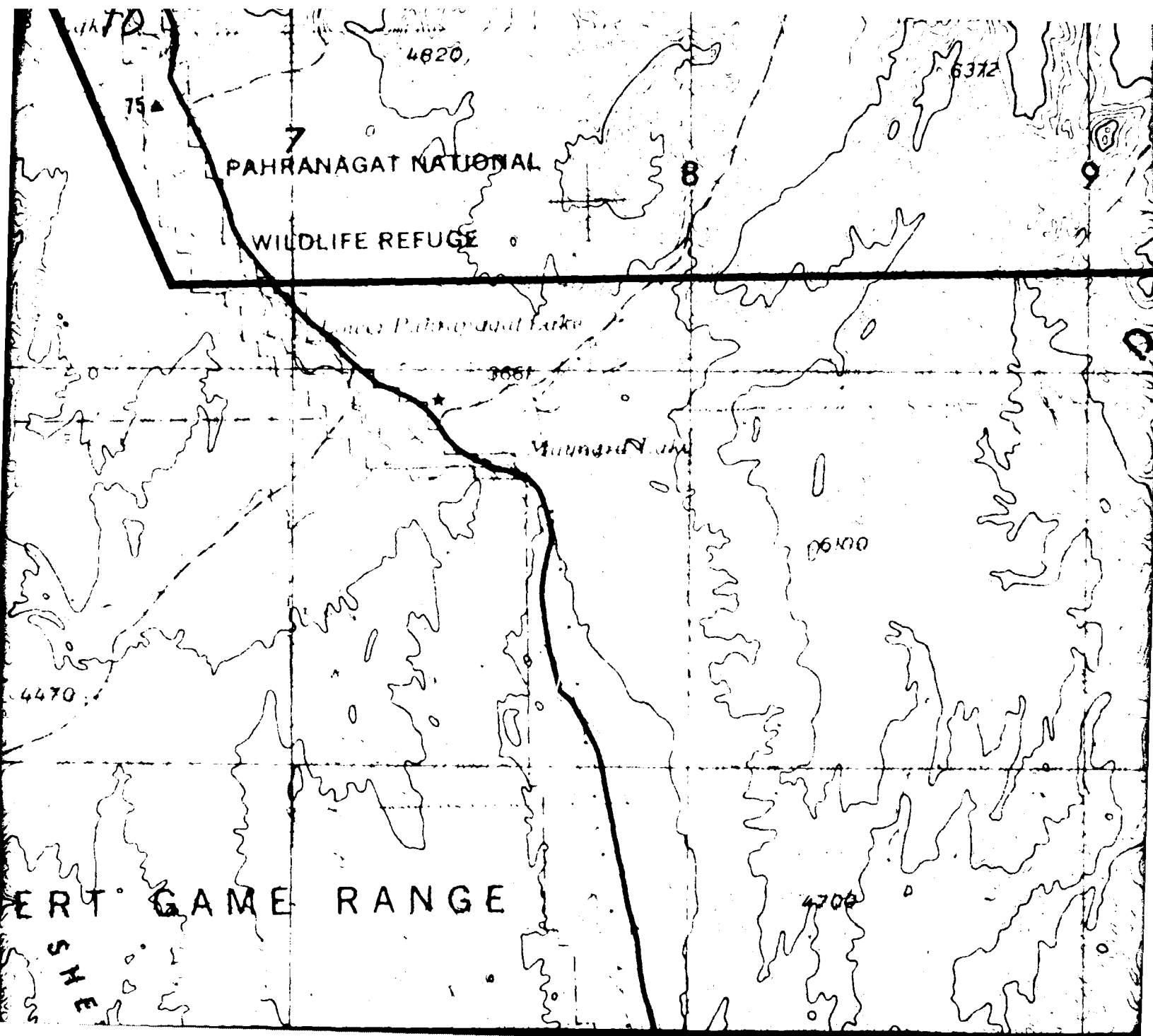
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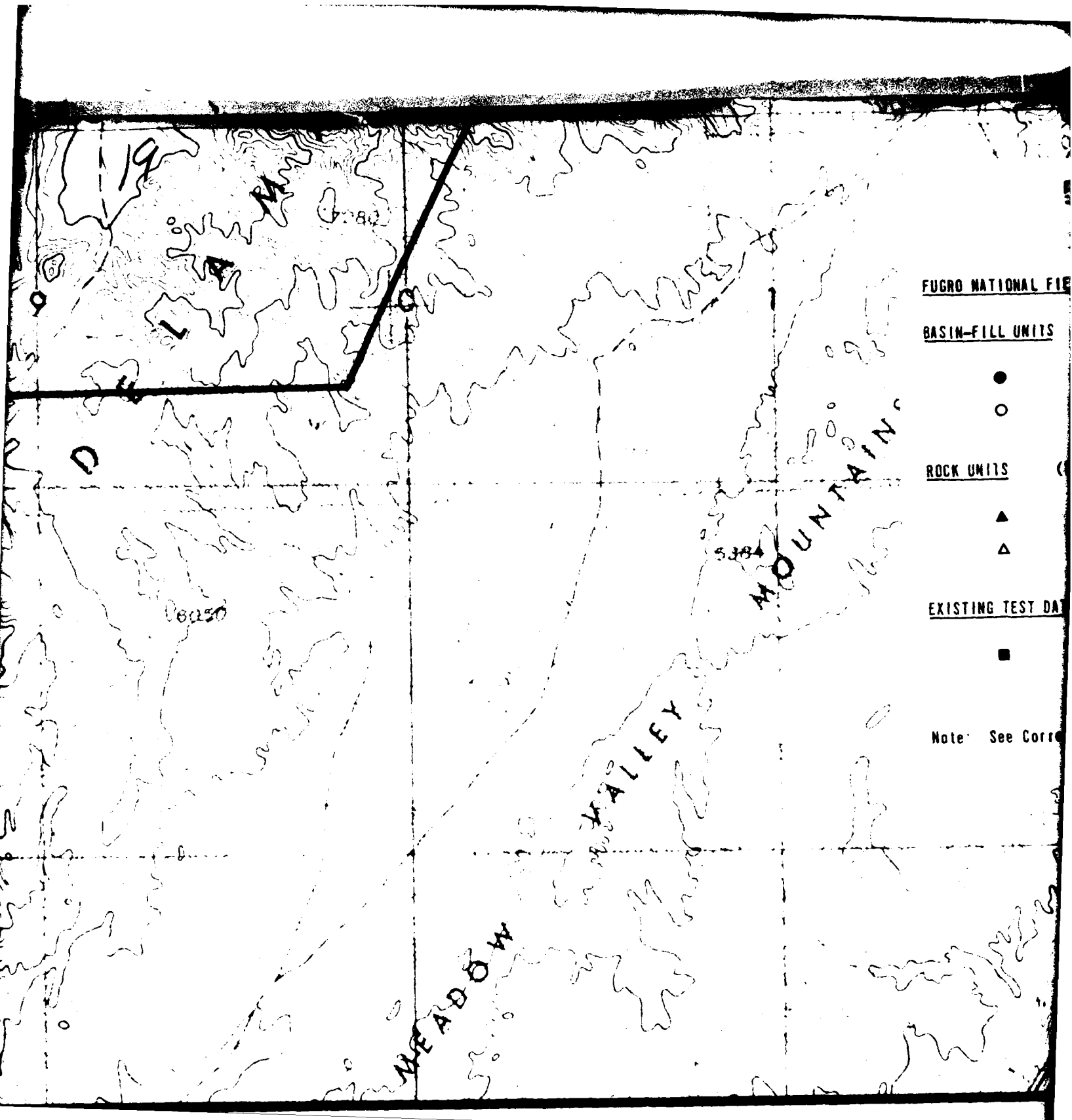


EXPLANATION

FUGRO NATIONAL FIELD STATIONS







EXPLANATION

FUGRO NATIONAL FIELD STATIONS

BASIN-FILL UNITS (Potential Coarse and/or Fine Aggregates)

- Data Stop, Sampled and Tested
- Data Stop

ROCK UNITS (Potential Crushed Rock Aggregates)

- ▲ Data Stop, Sampled and Tested
- △ Data Stop

EXISTING TEST DATA SITES

- Test Data Available

Note: See Corresponding Map Number in Appendix A for Detailed Information

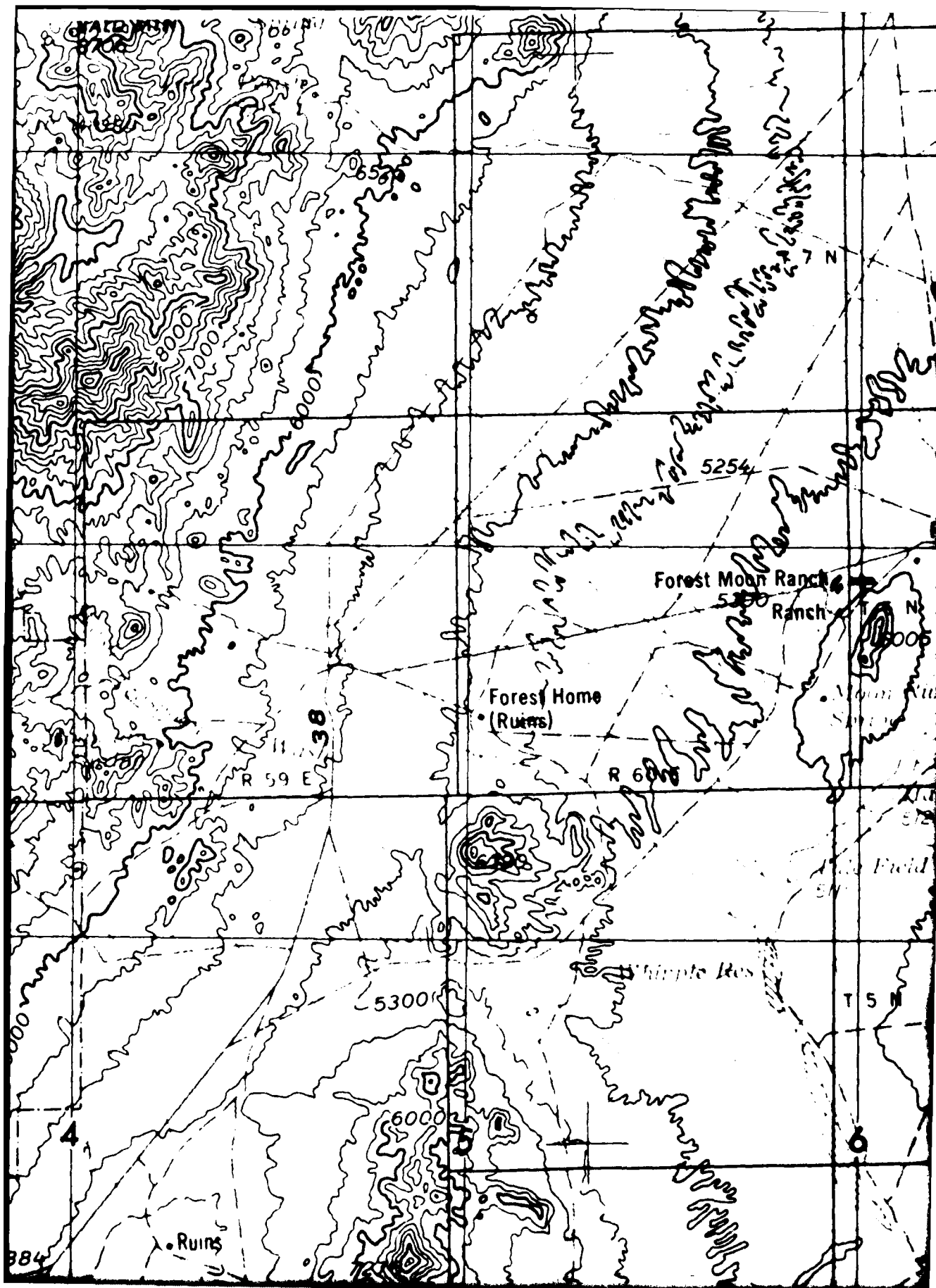
FUGRO NATIONAL FIELD STATION
AND EXISTING DATA SITE LOCATIONS
DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS

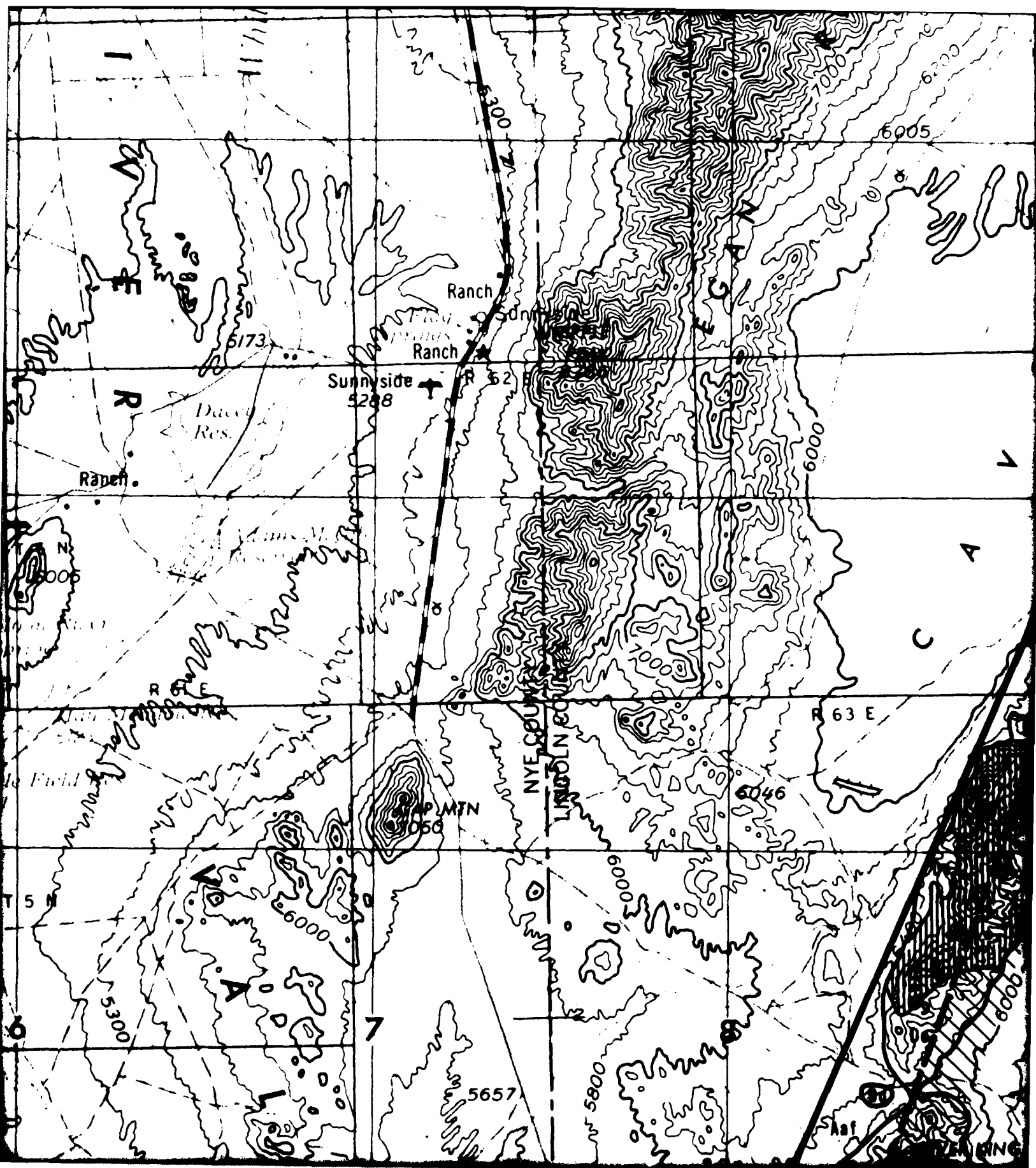
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DRAWING

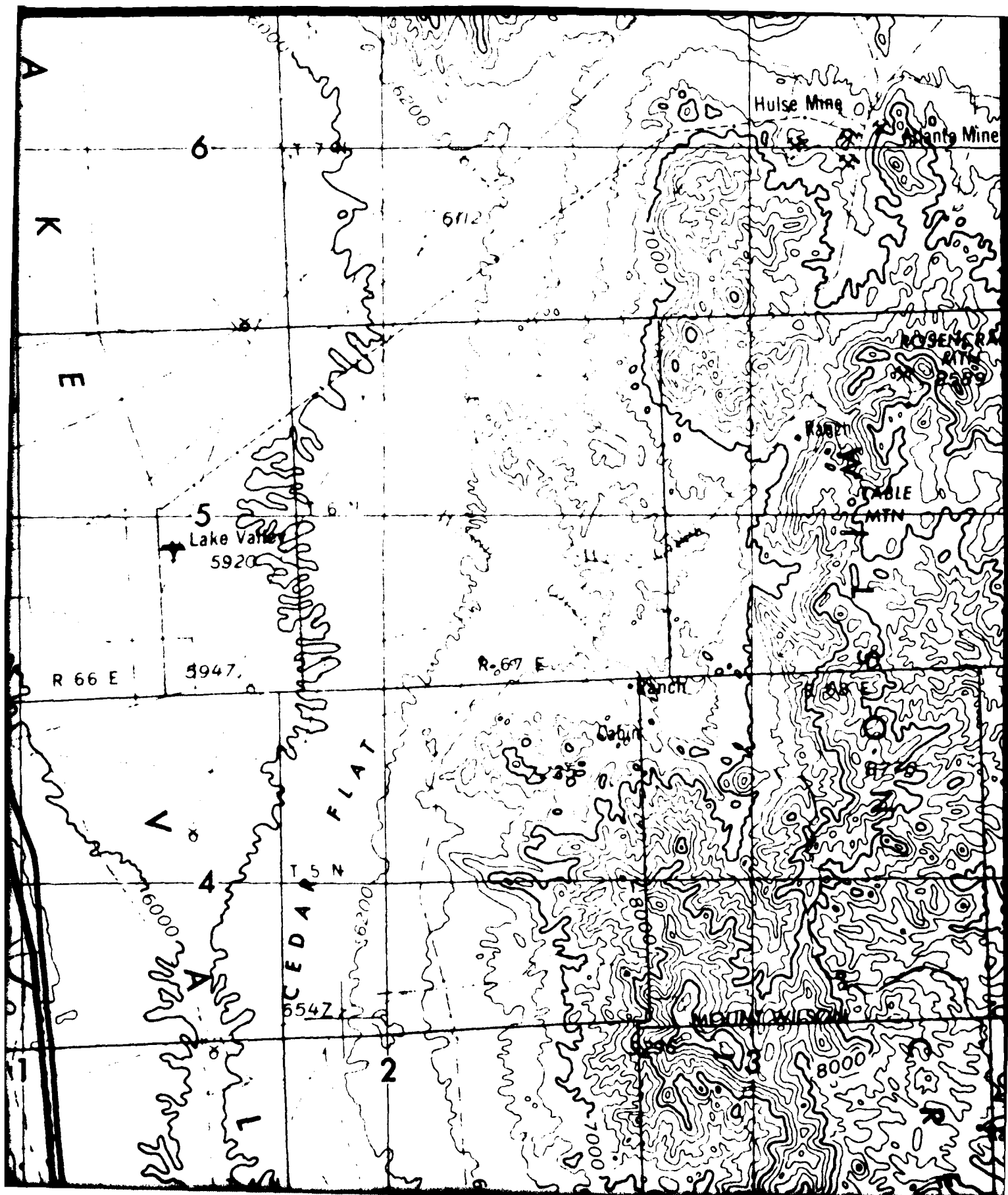
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FUGRO NATIONAL, INC.

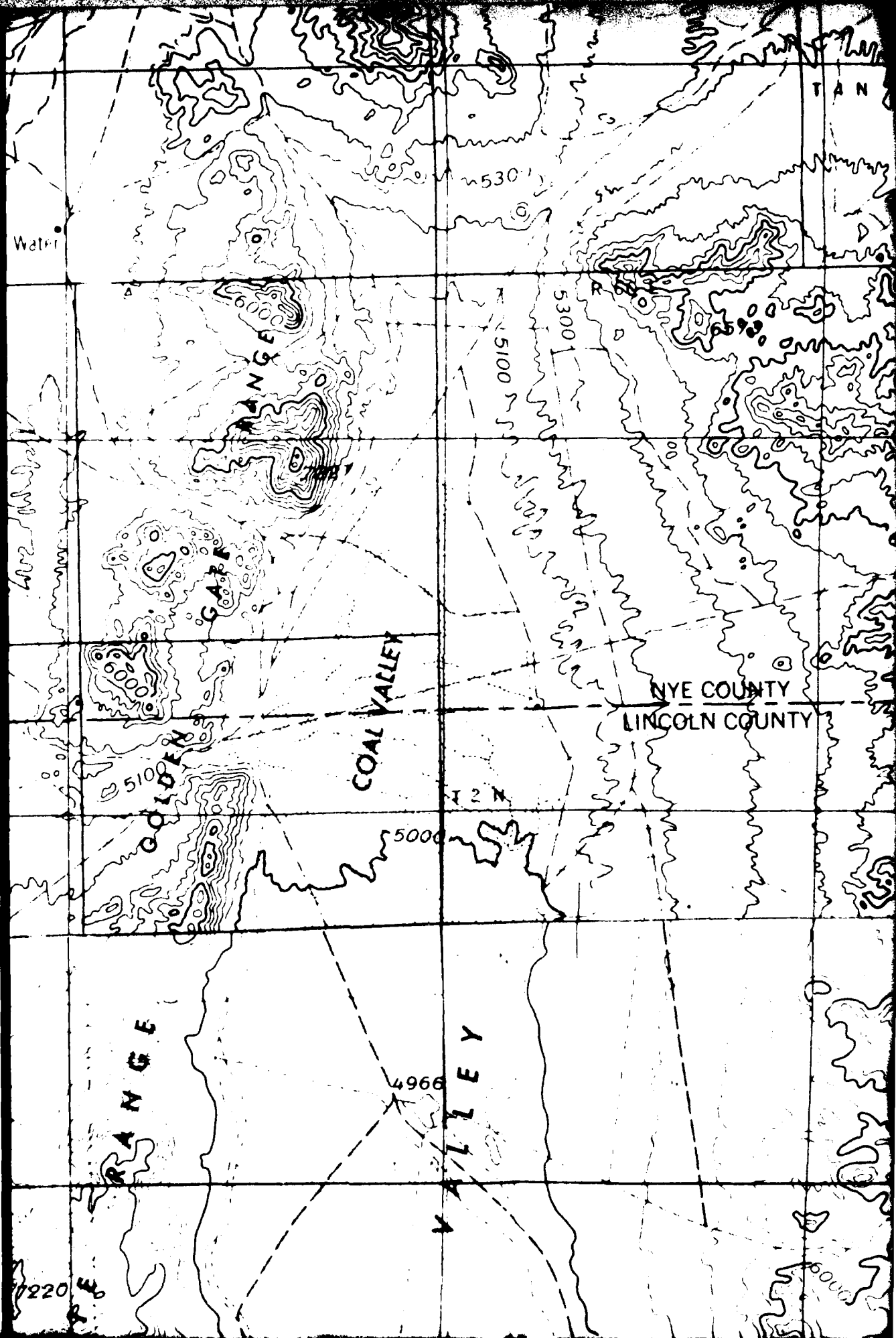




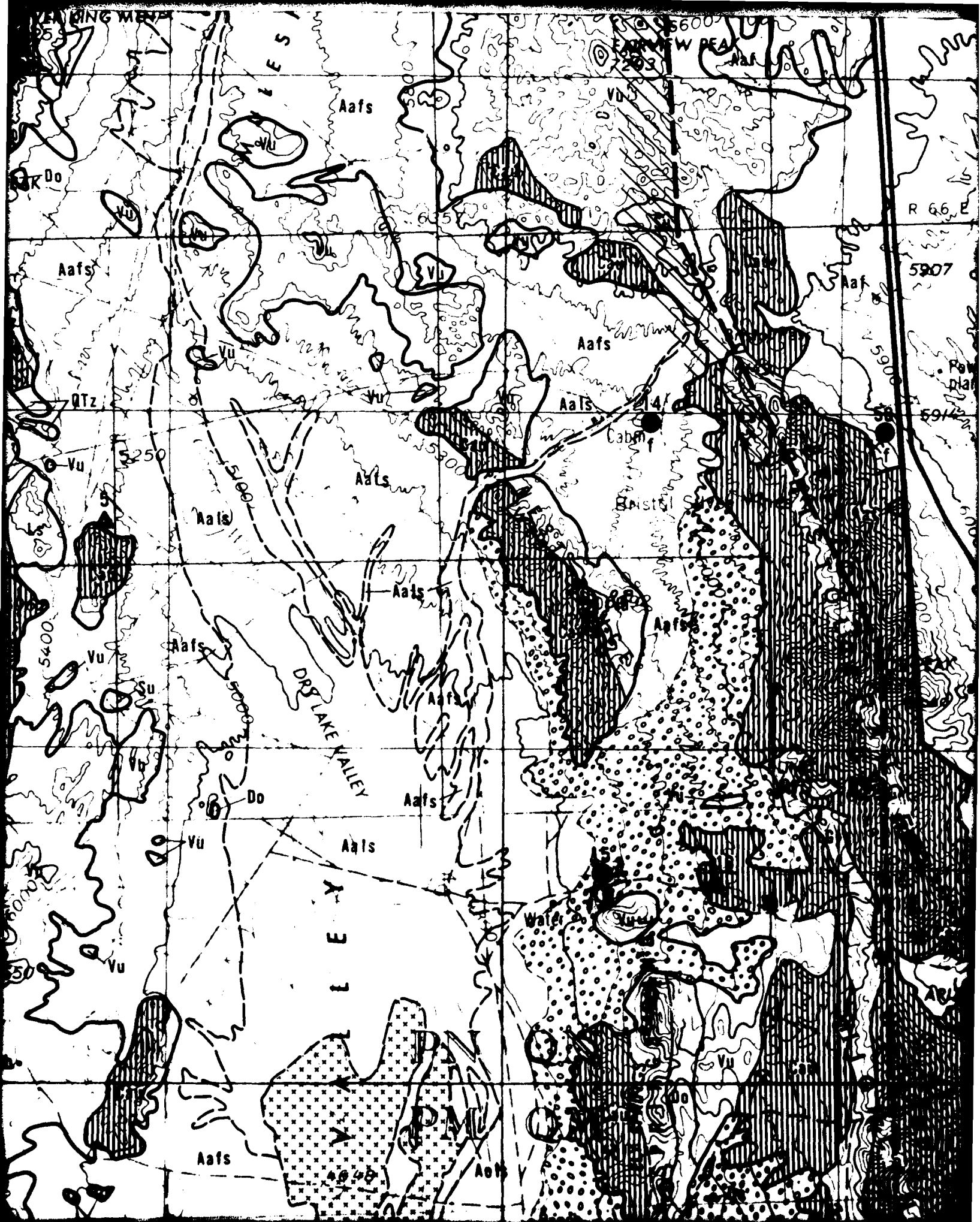


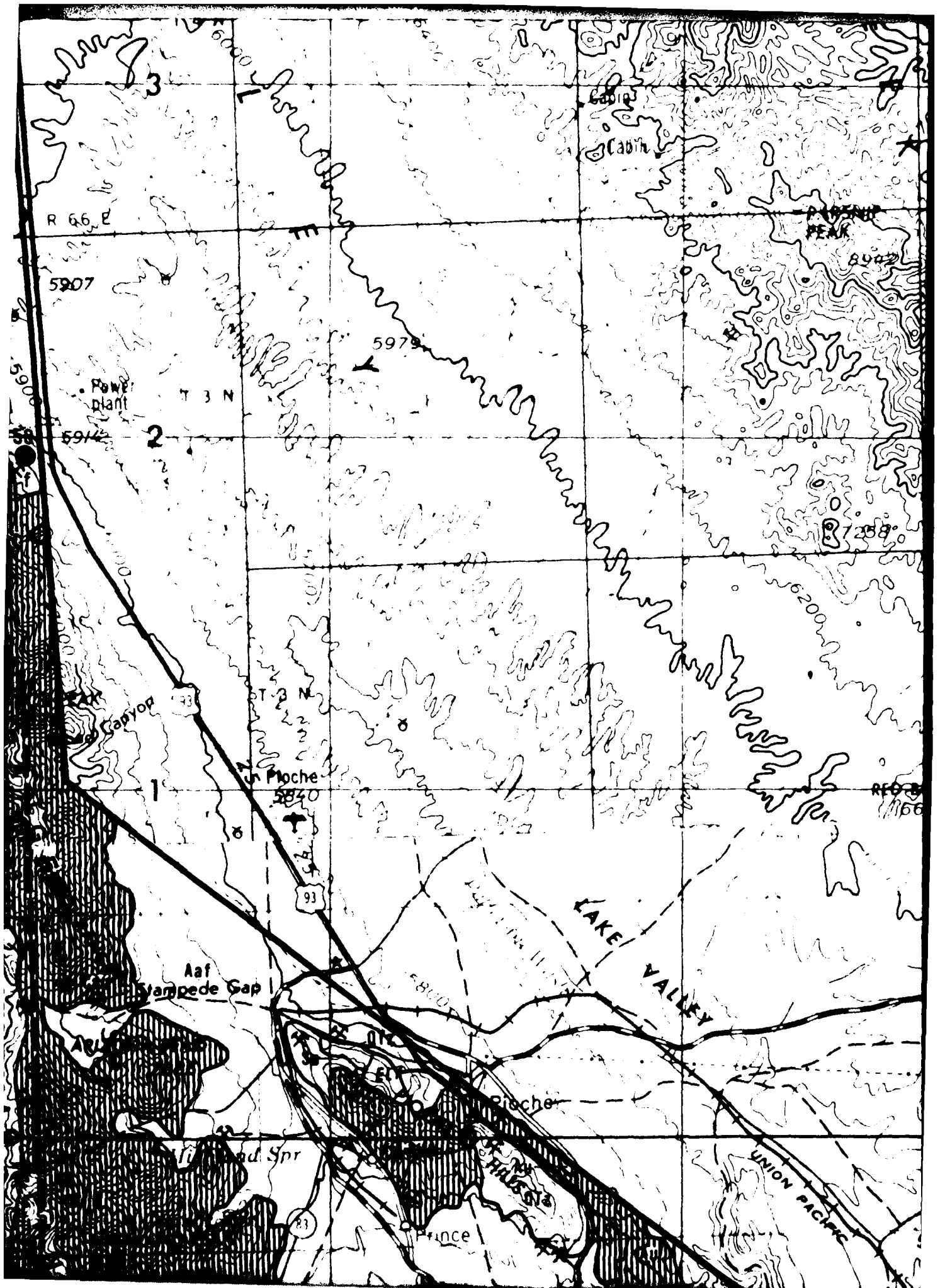


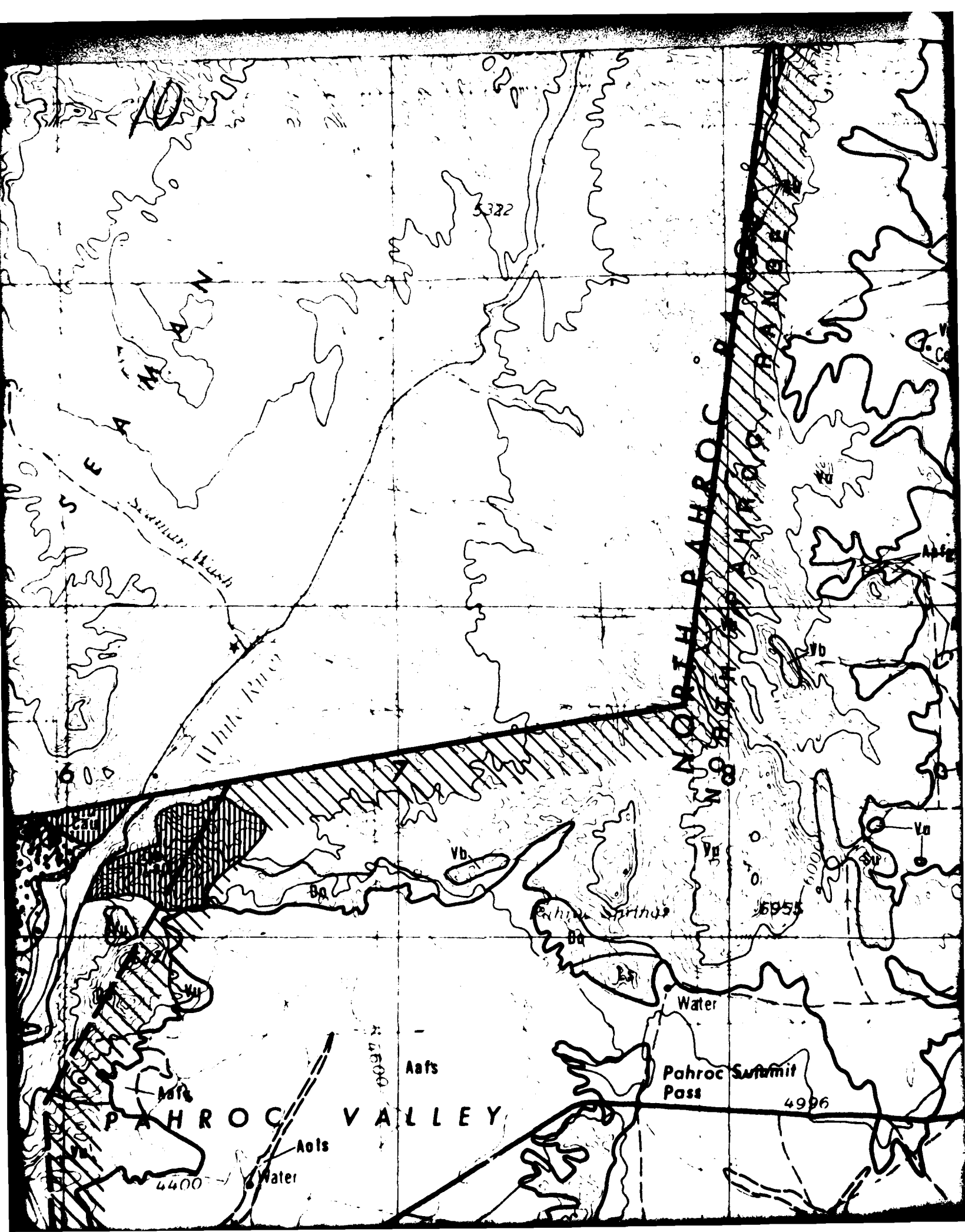
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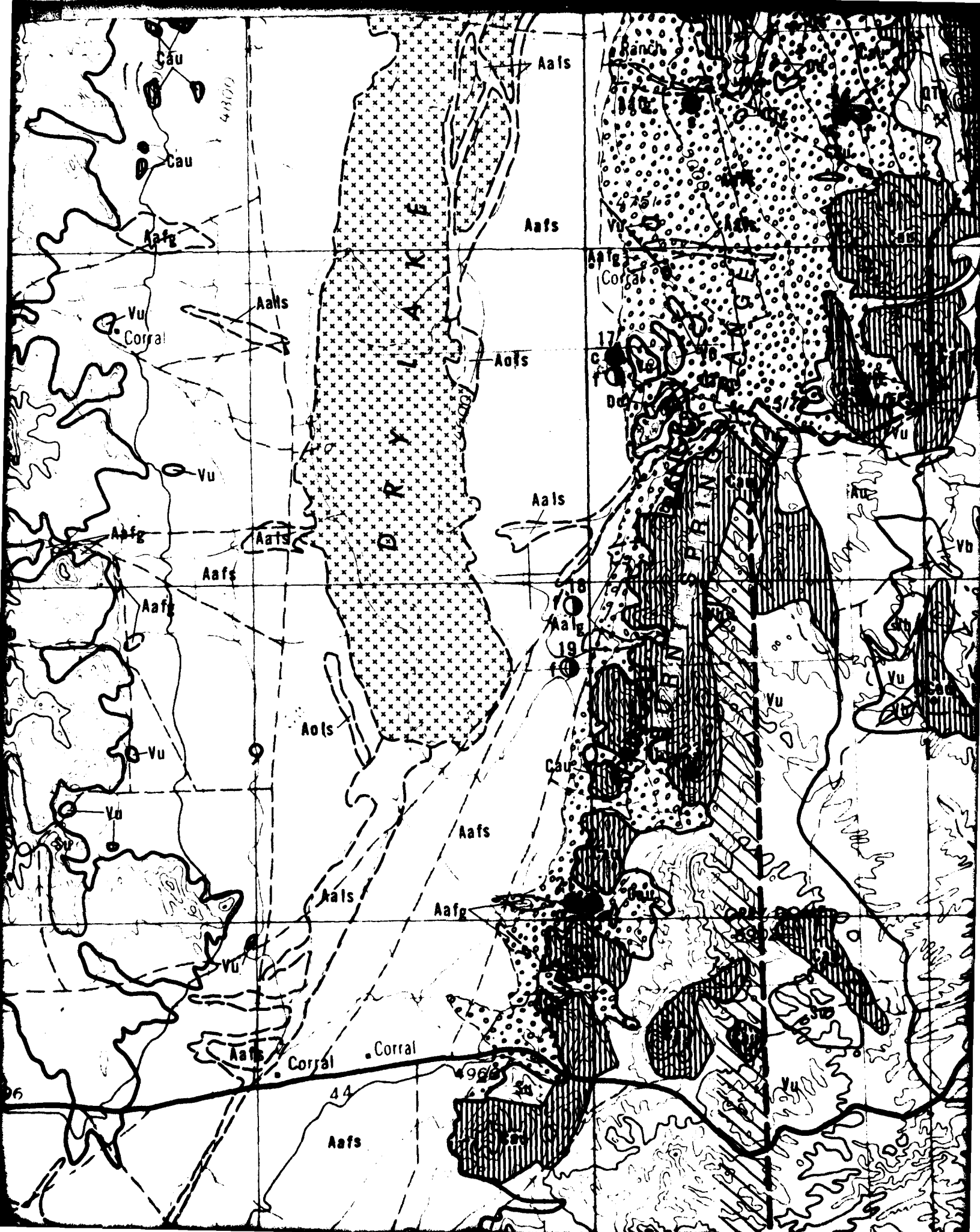


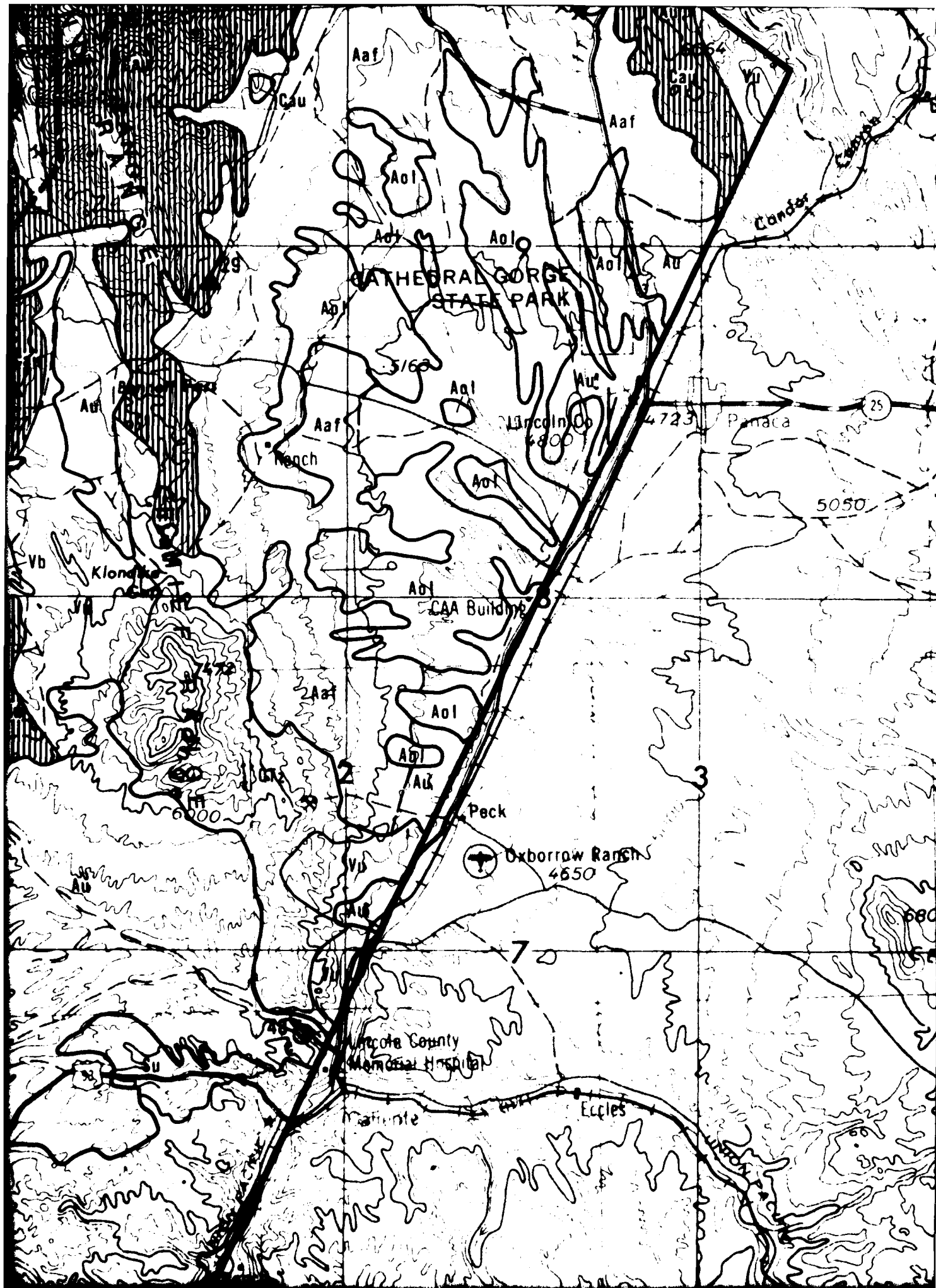


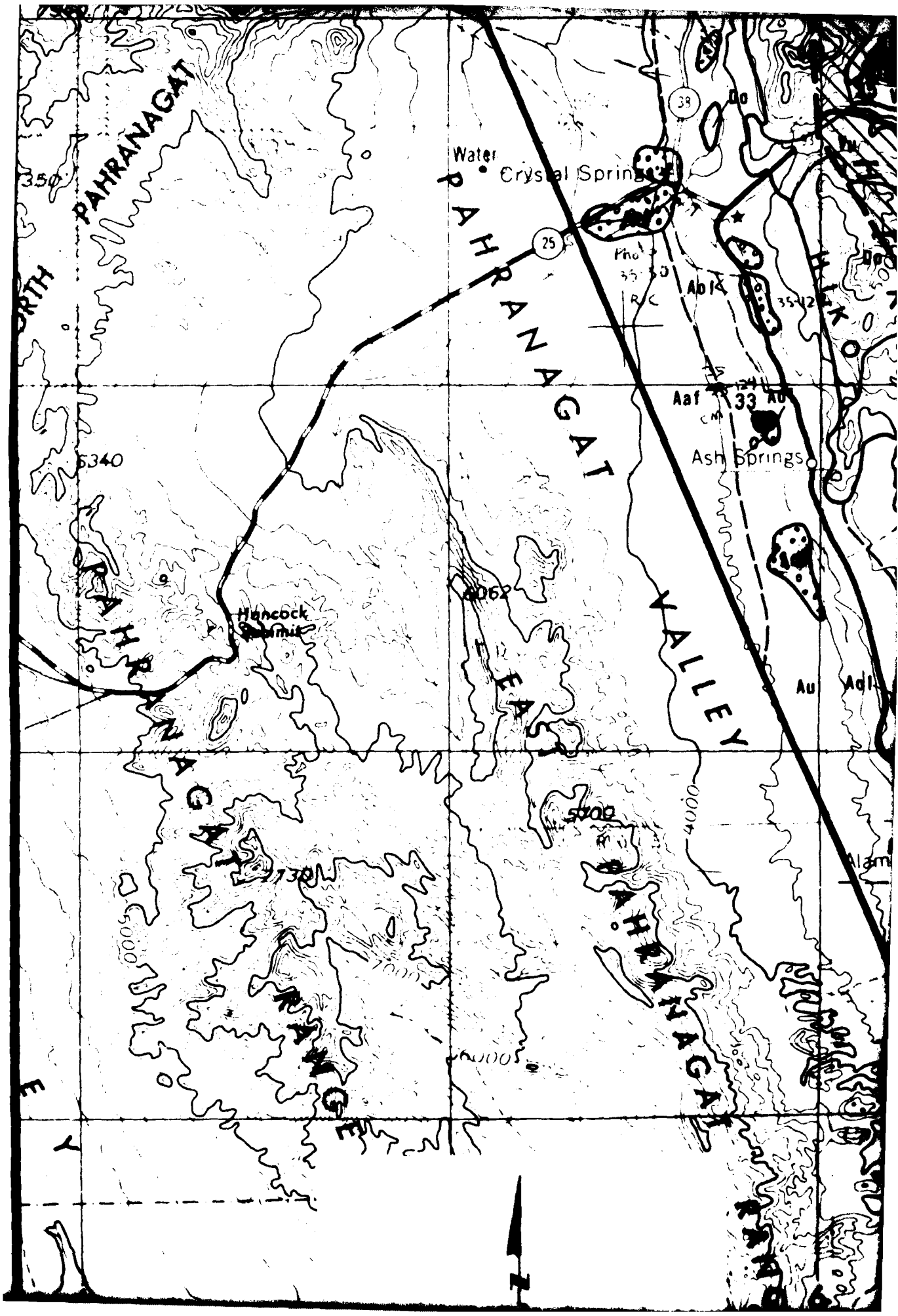


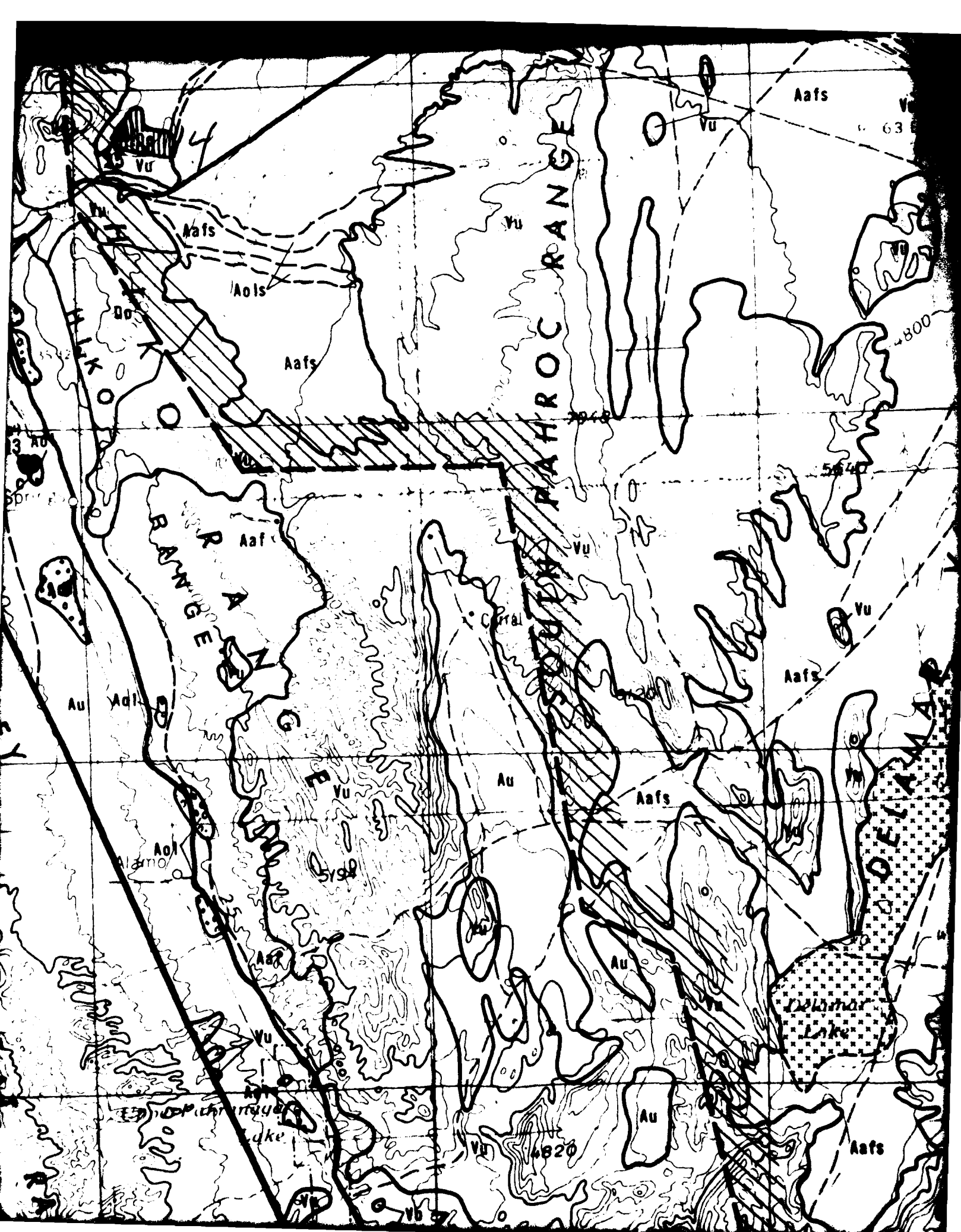


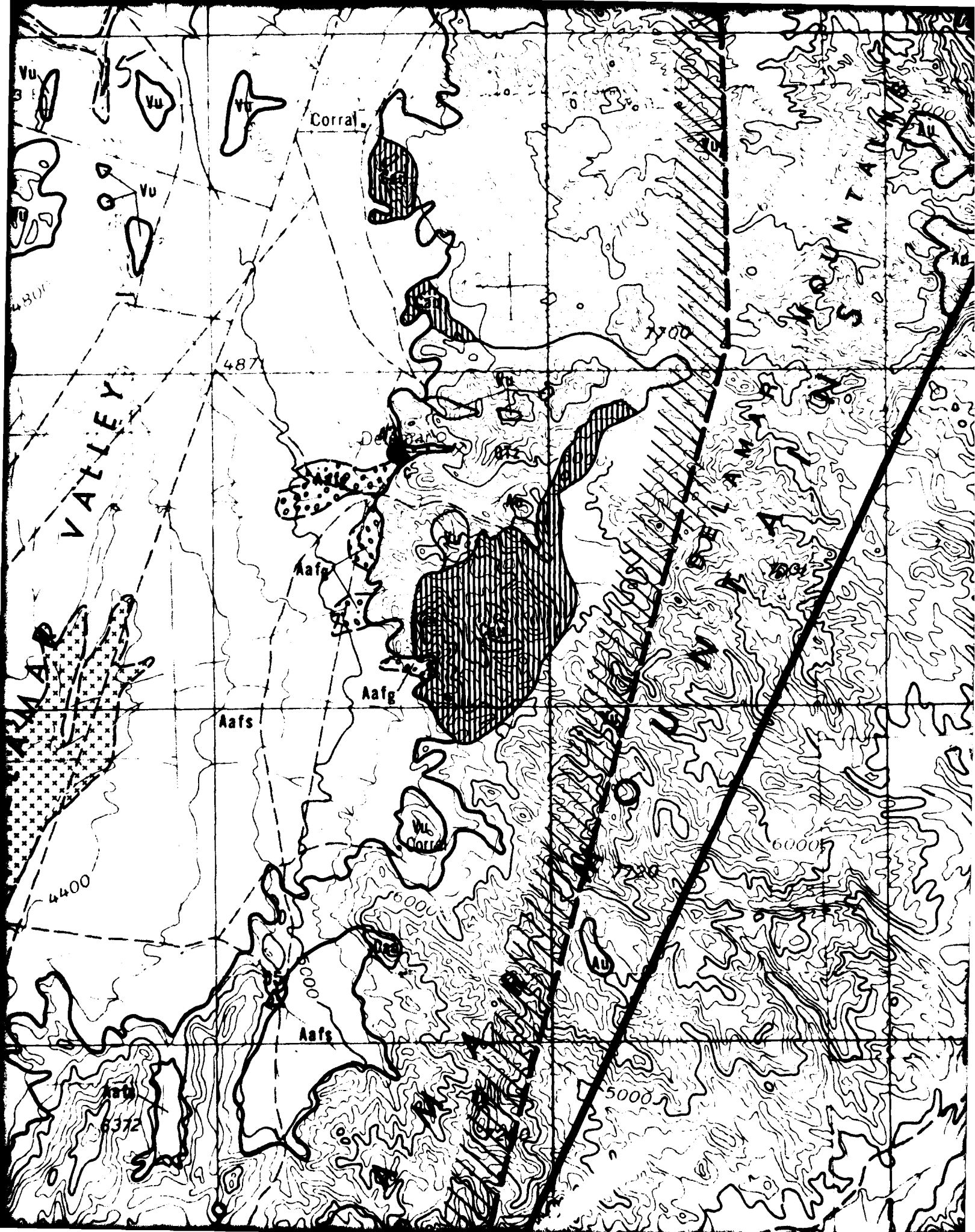














EXPLANATION

POTENTIAL AGGREGATE SOURCES

BASIN-FILL UNITS*

Aal	Stream Channel Deposits	(A1)
Aaf	Alluvial Fan Deposits	(A5)
Aol	Older Lacustrine Deposits	(A4o)
Au	Alluvial Deposits Undifferentiated	

ROCK UNITS*

Vb	Basalt	(I3)
Vu	Volcanic Rocks Undifferentiated	(I2 and or I4)
Gr	Granitic Rocks	(I1)
QTz	Quartzite	(M4 and or S1)
Ls	Limestone	(S2)
Do	Dolomite	(S2)
Cau	Carbonate Rocks Undifferentiated	(S2)
Su	Sedimentary Rocks Undifferentiated	(S)

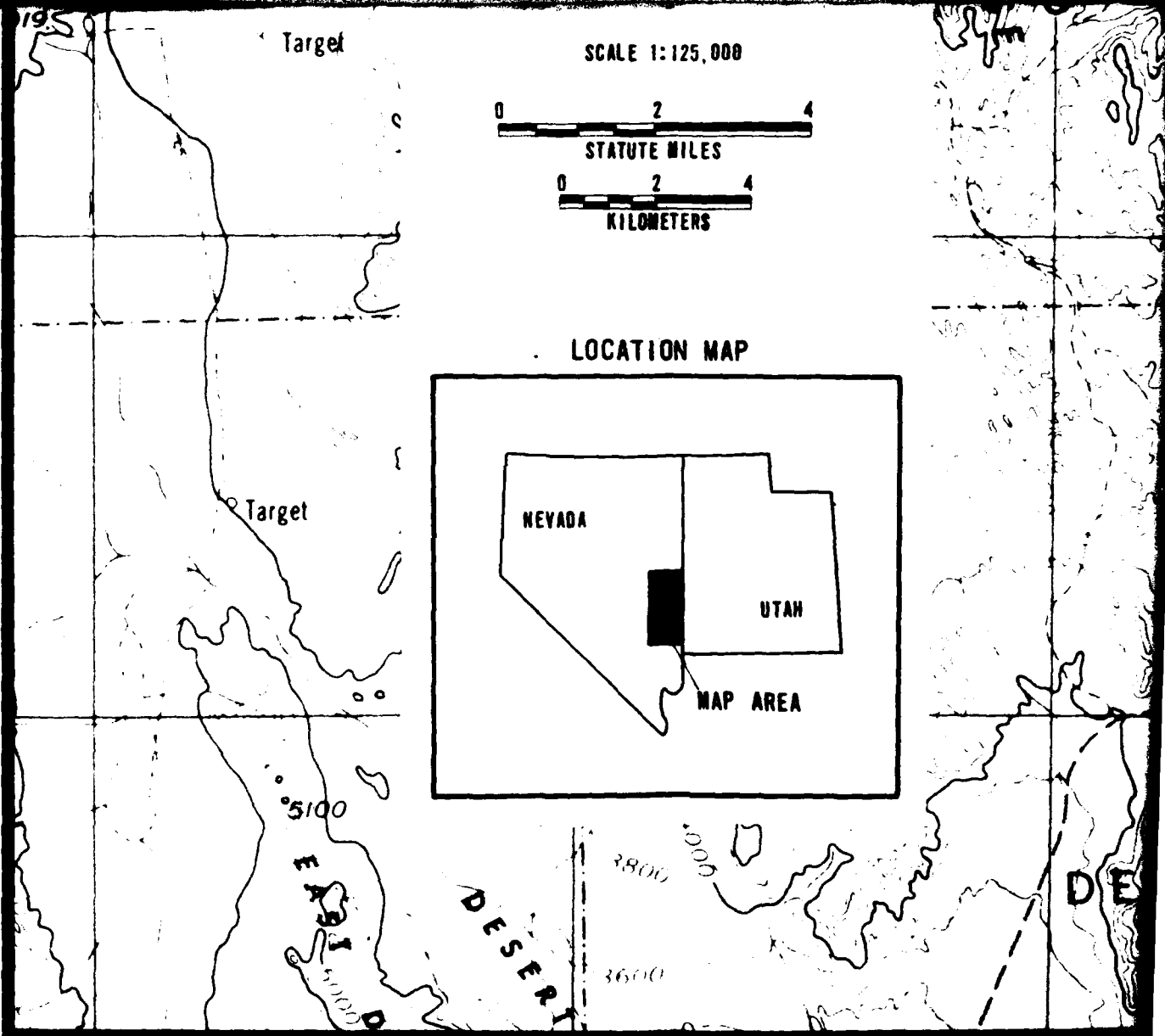
*Reference Appendix E for Symbol Explanation and Comparison

SYMBOLS

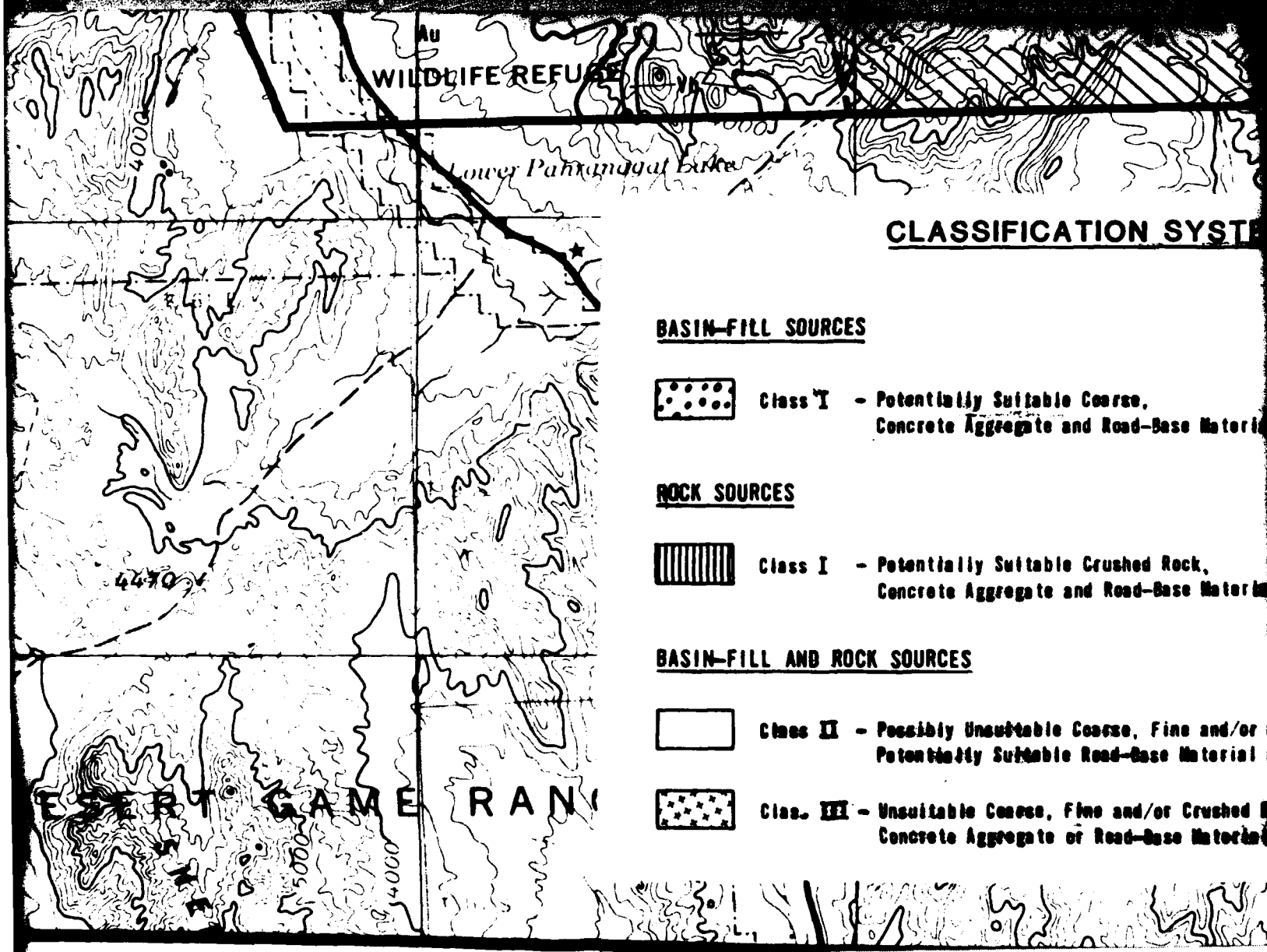
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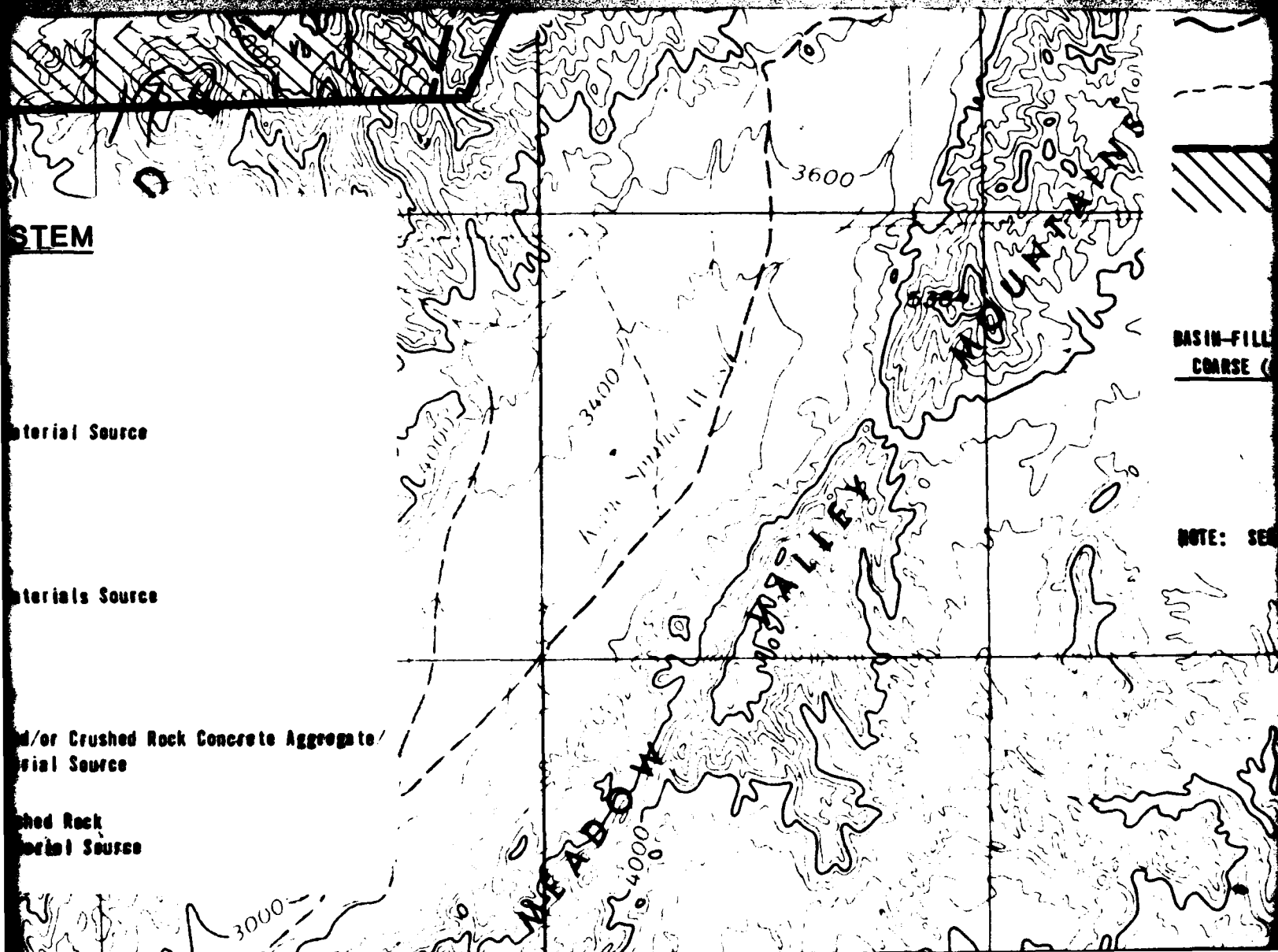
Material type (Aaf) and Grain Size Designation (g).
Grain size designations are gravel (g) and sand (s)
and are confined only to Verification Study Areas.

17



6 JUN 80





Geologic Contact, Dashed Where Approximate

Approximate Concrete Aggregate and/or
Road-Base Materials Source Boundary

Verification Study Area

FUGRO NATIONAL VALLEY-SPECIFIC AGGREGATE RESOURCES

SAMPLED AND TESTED FIELD STATIONS

BASIN-FILL AGGREGATE SAMPLE
COARSE (c) AND FINE (f)



CRUSHED ROCK
SAMPLE



CLASSIFICATION

CLASS I

CLASS II

CLASS III

NOTE: SEE CORRESPONDING MAP NUMBER IN APPENDIX A FOR DETAILED INFORMATION

AGGREGATE RESOURCES MAP
DRY LAKE, MULESHOE, DELAMAR, AND PAHROC VALLEYS

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2

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